ARITHMETIQUE
Made easie,
OR,

A perfect Methode for the true knowledge and practice of *Natural Arithmetique*, according to the ancient vulgar way, without dependence upon any other *Author* for the grounds thereof.

By Edm. WINGATE Esquire.

The second Edition.

Enlarged (at the request and with the approbation of the Author) *with divers* Chapters *and necessary* Rules;

Together with an *Appendix* containing 7 *Chapters*, whose *Contents* are as followeth, *viz.*

Chap.

1 *Of* Rules *of* Practice.
2 *Of Exchange of* Coins, Waights, *and* Measures.
3 *Of* Interest *of* Money.
4 *A Geometricall Demonstration of the* Rule of Alligation alternate; *where, of the* composition *of* Medicines.
5 *A Geometricall Demonstration of the* Rule *of* False.
6 *Subtile and pleasant Questions, exercising all the parts of* Naturall Arithmetique.
7 *Recreative Questions, exercising* Symbolicall Arithmetique, *and the* Rule *of* Algebra.

By JOHN KERSEY *Teacher of Mathematiques.*

Boëtius Arith. lib. 1. cap. 2.

Omnia quæcunq; à primævâ rerum naturâ constructa sunt, Numerorum videntur rationi formata: Hoc enim fuit principale in animo Conditoris Exemplar.

LONDON,
Printed by *J. Flesher* for *Phil. Stephens* at the Gilded *Lion* in *Pauls Church-yard*. 1650.

To the right Honourable,

THOMAS,

Earle of *Arundel* and *Surrey*, Earle Marſhall of *England*, &c.

Right Honourable,

THe good affection you beare to all kinde of Learning, and in particular to the Mathematiques, makes me adventure to preſent your Lordſhip with this Tractate of Arithmetique, becauſe that Art, compared with other Mathematicall Sciences, is as the Primum Mobile, in reſpect of the other inferiour Orbes:

For as the Poets used in times past to say of Venus, Sine Cerere & Baccho friget Venus, *so may I also confidently averre of them, without* Arithmetique *they are poore, and without Motion. Presuming therefore that your Lordship, loving the Art, cannot disaffect the Artist, nor his intention to doe good in that kind, I am bold to shelter this Treatise under your Lordships protection, humbly intreating gratious acceptation, and earnestly desiring for ever to remain,*

Your Honours, in all service affectionately devoted

Edm. VVingate.

The Preface to the ſecond Edition of this firſt Book:

Relating alſo to the other Books already publiſhed by the *Authour*.

ABout twenty yeares ſince, after I had in ſome meaſure before that time exerciſed my ſelf in the ſtudy of the *Mathematiques*, and by that means diſcovered ſome expeditious wayes of working by *Logarithmes* (an invention then both freſh and rare) which (as was then conceived) might be uſefull for the publick, at the inſtance of ſome of my friends; I framed two Books of *Arithmetique*, intending the firſt (being this) onely as a key to open the ſecrets of the other, which treats of *Artificiall Arithmetique* performed by *Logarithmes*; and therefore did then in that firſt (for brevity ſake) omit divers pieces of naturall or vulgar *Arithmetique*, which for the perfect and univerſall underſtanding thereof were neceſſary to have been inſerted; Howbeit, now the firſt impreſſion of both thoſe Books being ſpent: I have been of late importuned to take ſome care of this ſecond Edition, and being given to underſtand that (by reaſon of the Method) it had been generally well approved, and much uſed by divers, that teach *Arithmetique*, I prouided my endeavour therein; but

What was the Authors deſigne in the firſt Edition of this Book.

What was omitted then.

but not long after foreseeing that my other necessary imployments would much retard the perfecting thereof (as I did intend it) I imparted my thoughts concerning the same to Mr. *John Kersey*, whom I did know to be an Industrious Man, well experienced in teaching that Art, and was Instant with him to take the pains of inserting such Chapters, Rules and Examples into this first Book, as I then mentioned unto him, and also to adde what else he should conceive necessary to make it *opus absolutum*, a perfect work; All which he hath performed by divers insertions in severall places of the work, besides the addition of certain Chapters (intirely his own) relating to severall particulars, as doth more fully appear in the Table prefixed: So that for understanding naturall or vulgar *Arithmetique*, there is (as I conceive) no need of repairing to any other Author for supply thereof. My desire likewise was, that it might be fitted for the best advantage of such as teach that Art, as well in respect of method and order, as also of compendiousnesse, truth, and exact correction, both of the Text and Numbers: This also hee hath faithfully endeavoured to perform with as few mistakes or errours as may probably bee expected in a worke of this nature: So that (it is confidently hoped) the Reader having diligently perused this first Book, may thereby obtain compleat knowledge in Naturall or Vulgar *Arithmetique*, which I have thought convenient to bee Printed apart from the other, to the end that such as will content themselves with this of *Naturall Arithmetique* may not be charged with the buying of the other, unlesse they so please; nevertheless, if they (having herein passed the more rugged

The course taken for supply now.

To make this a perfect work. What is now added.

For the benefit of the teachers of this Art.

And the Readers obtaining compleat knowledge in vulgar Arithmetique.

Why this first part printed alone.

rugged and uneven pathes of *Naturall Arithmetique*) are afterwards desirous to understand the grounds and order of *Arithmetique Artificiall*, they shall be by the other Booke conducted thereinto as into a plain and spacious Champaigne, where the wayes are smooth and easie to passe; for what they shall finde here performed by *Multiplication* and *Division*, they shall be there taught to expedite by *Addition*, and *Subtraction*; and the extraction of rootes a more easie way yet, *viz.*

What is included in the second part.

That of the *Square roote*, by *Bipartition* or *Division* by 2; and the other of the *Cube Roote* by *Tripartition* or *Division* by 3. Howbeit the last Booke cannot be well understood without a perfect knowledge of the first, divers Rules of this opening the way to the discovery of that: Nevertheless, (if before the second Booke can bee conveniently published) any shall desire some generall light of working by *Logarithmes*, hee may (in the mean time) bee in some competent measure acquainted therewith by my other Bookes heretofore published, Intituled, 1, *The Construction and use of the Logarithmicall Tables*. 2 *The use of Logarithmes in Geometrie, Astronomie, Geographie*, and *Navigation*: And 3, *The use of the Rule of Proportion*; before the second of which is also prefixed a Table of an Hundred thousand *Logarithmes* ingeniously contracted by Master *Roe*, and exactly corrected at the Presse by Master *Butler* deceased: Howbeit in these last mentioned Treatises, he must not expect to finde the Universall use of *Logarithmes* throughout all the parts of *Arithmetique*, which the second Booke (now intended) will afford him: For what this Booke

How the Authors intention for the 2 Booke is in part already performd by his other Bookes published formerly.

presents unto you, according to the antient vulgar way of working by the *Numbers themselves*, the other that followes performs the same by *borrowed Numbers* called *Logarithmes*; And both these taken together contain in them an intire body of *Arithmetique* both *Natural* and *Artificiall*, which if accepted with as cleare an affection as intended, 'tis all I looke for, expecting nothing for the fruit of my labours, but favourable acception, and (in that) the publique good.

Edmond Wingate.

The

The *Books*, mentioned in the Preface, are ſold by *Philemon Stephens* at the gilded-Lion, in *Pauls Church-yard.* viz.

1. THe Conſtruction and uſe of the *Logarithmeticall* Tables, whereby *Multiplication* is performed by *Addition*, *Diviſion* by *Subtraction*, and the reſolution of *Triangles* right lined and *Sphericall* by *Addition* and *Subtraction*. Firſt publiſhed in *French*, now the third time printed in *Engliſh* in 12°.

2. Two Tables of *Logarithmes*: the firſt containing the *Logarithmes* of all numbers from 1. to 100000. contracted into a portable volume, by *N. Roe*. The 2d. the *Logarithmes* of the right *Sines* and *Tangents* of all the Degrees and Minutes of the quadrant, each Degree divided into 100. minutes, and the *Logarithme*, of the *Radius* or *Semidiameter* being 10, 00000 00000.

To which is annexed their admirable uſe for reſolving Problemes,

in

in { *Geometry*, *Aſtronomy*, *Geography*, & *Navigation*.

3. The uſe of the Rule of *Proportion* in *Arithmetique* and *Geometrie*, wherein is inſerted the Conſtruction and uſe of the ſame Rule in queſtions that

concern { *Aſtronomy*, *Dialling*, *Geography*, *Navigation*, } { *Gaging of veſſels*, *Military orders*, *Intereſt* and *Annuitie*.

4. The Conſtruction and uſe of the line of Proportion, whereby the hardeſt queſtions of *Arithmetique* and *Geometry* in broken and whole numbers are reſolved by *Addition* and *Subtraction*, printed in the yeare, 1628.

Alſo at the ſame place is to be ſold,

Arithmetica Logarithmica, ſive Logarithmorum Chiliades centum, pro Numeris naturali ſerie creſcentibus ab unitate ad 100000.

Autore H. Briggio.

Tri-

Trigonometria Britannica, ſive De Doctrina Triangulorum libri duo. Autore *Hen. Briggio.*

A Treatiſe of Globes *Cœleſtiall* and *Terreſtriall*, written in Latine by Maſter *Robert Hues*. Illuſtrated with Notes, by *Io. Iſa. Pontanus*, Engliſhed by *John Chilmead* of Chriſt-Church in *Oxford* 8°.

Rabdologia, or the art of Numbring by Rods, whereby the Operations of *Multiplication* and *Diviſion*, Extraction of Roots, *&c.* are performed by *Addition* and *Subtraction*, with many Examples for practice of the ſame, by *Seth Partridge*.

Other Books tending to the *Mathematicall Sciences* are there likewiſe to be ſold.

A Ta-

A Table of the Contents of this Booke, wherein ſuch Chapters which are totally added in this Edition, may be diſcovered by this mark, ☞ the reſt of the inſertions are mentioned next after the Title of their reſpective Chapter.

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Pag.	Line	Faults	Corrected
20	13	24 s. $\frac{647}{960}$	24 $\frac{647}{960}$ lb.
22	4,15	*tenths*	tens
41	22	*leſſe*	greater
54	19	*either*	each
67	23	*denominat, or*	denominator,
293	10	525	425
368	6	101 $\frac{4}{3}$	101 $\frac{4}{21}$

THE

ARITHMETIQVE NATURALL

The first Book.

Chap. I.
Of Number.

I. *Arithmetique is the Art of accompting by Number.* As magnitude or greatneſſe is the ſubject of *Geometrie*, ſo multitude or number is that of *Arithmetique.*

II. *Number is that, by which every thing is numbred.* Number. *Vide Rami Arith. cap.* 1. *prop.* 4.

III. *The Notes or Characters, by which Number is ordinarily expreſſed, are theſe;* 1 *one*, 2 *two*, 3 *three*, 4 *foure*, 5 *five*, 6 *ſixe*, 7 *ſeven* 8 *eight*, 9 *nine*, 0 *nothing.*

IV. *Theſe Notes are either ſignificant figures, or a cypher.*

V. *The ſignificant figures are the firſt nine*, viz. 1, 2, 3, 4, 5, 6, 7, 8, 9. The firſt whereof is more particularly termed an *Unit*, or *Unitie*, and the reſt are ſaid to be compoſed of *Unities*: So 2 is compoſed of two unities, 3 of three unities, &c.

VI. *The Cypher is the laſt, which though of it ſelf it ſignifieth nothing, yet being annexed before, or after any of the reſt, increaſeth, or leſſeneth their value*: As ſhall farther appear hereafter.

VII. *The value of theſe Notes is expreſſed by Degrees and Periods.*

VIII. *The degrees are three.*

The degrees of Number.

IX. *The firſt is the firſt place of a number towards the right hand, which always ſignifieth it ſelf once*, as 2 two, 3 three, &c. And this is called the place of *Units*.

X. *The ſecond degree is the ſecond place towards the ſame hand, and then the firſt note towards the right hand ſignifieth it ſelf once, as before, and the other ſignifieth it ſelf ten times*: So theſe figures 20, ſignifie twenty, and theſe 30, thirty, likewiſe theſe 23, tweity three, &c. And this ſecond place is called the place of *Tens*.

XI. *The third is the third place of a number, towards that hand and then the firſt note towards the ſame hand ſignifieth it*

it self once, the next ten times it self, and the last an hundred times it self: So these figures 100, signifie one hundred, these 200, two hundred, these 300, three hundred, and these 123, one hundred twenty three, &c. And this is termed the place of *Hundreds*.

XII. *A Period is when a number consisting of moe notes then three, with each three notes thereof (beginning at the right hand) distinguished by points or commaes: For those severall parts of the number so distinguished, are called Members, or Periods.* A Period.

So the number 23437205740304, being distinguished by *Periods* will stand thus, 23,437,205,740,304. of which in the first *Period* towards the right hand the first figure towards the same hand is, as before, the place of *Units*, the second the place of *Tens*, the third the place of *Hundreds* again in the second *Period* the first figure towards the same hand is the place of *Thousands*, the next *tens of thousands*, and the last *hundreds of thousands*: Then in the third *Period* the first is the place of *Millions*, the next *tens of millions*, and the last *hundreds of millions*: Fourthly, in the fourth *Period* the first are *thousands of millions*, the next

ten thousands of millions, and the last *hundred thousands of Millions*: Lastly, in the fift *Period*, the first are *Millions of Millions*, the next *tens of Millions of Millions*, &c. So that if you would pronounce the number above mentioned, you shall read it *thus*, beginning with the first figure toward the left hand; 1 Twentie three Millions of Millions. 2 Foure hundred thirtie seven thousand. 3 Two hundred and five millions. 4 Seven hundred and fourtie thousand. 5 Three hundred and foure.

XIII. *Every number is either simple or mixt.*

XIV. *A simple number is that whose parts are of one and the same kind, that is, either whole or broken.*

A whole Number.

XV. *A whole number is that which consists of Integers, that is, intire Vnities.* As 24 which is compoſed of foure, and twenty *Integers*, or intire unities.

A Fraction.

XVI. *A broken number (otherwise called a Fraction) is onely part of an Integer*; As if you would expresse in figures the length of a peece of cloth, that contains *three fourths*, or (which is all one) three quarters of a *yard*, you are to write it *thus*; ¾ that is, an intire yard being supposed to be divided into foure equall parts, the length of

of the peece propounded is *three* of thoſe foure parts: in like manner (a foot being divided into 12 *Inches*) you muſt write ſixe inches *thus* $\frac{6}{12}$: that is, ſixe *twelves* of a foote. or if the foot be divided into an hundred parts, to expreſſe five and twentie of thoſe parts ſet them down *thus*: $\frac{25}{100}$ that is, five and twentie *hundreds* of a foot.

XVII. *A broken number conſiſts of two parts, the Numerator, and the Denominator.*

XVIII. *The Numerator is the number placed above the Line*: as in the laſt examples, 3, 6, 25.

XIX. *The Denominator is the number placed under the line*: as theſe, 4, 12, 100.

XX. *A broken number is either proper or improper.*

XXI. *A proper broken number is that, whoſe Numerator is leſſe then the Denominator*: Such as are the fractions before mentioned $\frac{3}{4}$ $\frac{6}{12}$ and $\frac{25}{100}$.

XXII. *A proper broken number is either ſingle or compound.*

XXIII. *A ſingle broken number is that which* conſiſts of *one* Numerator, and *one* Denominator: Such as are $\frac{3}{4}$ $\frac{6}{12}$ $\frac{25}{100}$ and the like.

XXIV. *When a ſingle broken number* A Deciſmall.

hath for his Denominator a number consisting of an unitie in the first place toward the left hand, and nothing but Cyphers towards the right, it is more particularly called a Decimall: Of this kinde are these that follow, $\frac{5}{10}$ that is, five *tenths*, $\frac{5}{100}$ five *hundreds*, $\frac{25}{100}$ five and twenty *hundreds*, $\frac{50}{1000}$ fifty *thousands*, $\frac{25}{10000}$ five and twenty *ten thousands*, &c.

XXV. *A decimall may be expreſt without the denominator by prefixing a point before the numerator*: So $\frac{5}{10}$ may be written *thus*, .05, and $\frac{25}{100}$ *thus*, .25.

XXVI. *In decimalls, when the numerator consists not of so many places as the denominator hath cyphers, fil up the void places of the numerator with cyphers*: So $\frac{5}{100}$ $\frac{50}{1000}$ and $\frac{25}{10000}$ are written thus, .05, .050, .0025.

XXVII. *In decimalls thus expreſt, the denominator is discoverable by the places of the numerator*: for if the numerator consists of two places, the denominator is an unity with two cyphers: if of three, the denominator hath three cyphers annexed, &c. So the denominator of .25, is 100, and the denominator of .050, is 1000.

A com. pound Fraction.

XXVIII. *A compound broken number*, (*otherwise called a Fraction of a Fraction*)

is that which hath more numerators and denominators then one, which kind of broken numbers are diſcoverable by this word [*of*] *which is interpoſed between their parts*: As $\frac{2}{3}$ *of* $\frac{1}{4}$ is a Fraction of a Fraction or compound broken number, and expreſſeth two thirds of three fourths of an *Integer*, viz. a pound *ſterling* being ſuppoſed the *Integer*, and firſt divided into foure parts, three of thoſe foure parts are equall to 15, s. Again if the ſaid $\frac{1}{4}$ or 15, s. be divided into three parts, two of thoſe three parts are equall to 10, s. So the ſaid compound broken number $\frac{2}{3}$ of $\frac{1}{4}$ of a pound *ſterling* doth expreſſe 10 s. In like manner the compound broken number $\frac{1}{4}$ of $\frac{2}{3}$ of $\frac{2}{5}$ of a pound *ſterling*, that is one fourth of three fourths of foure fifths of a pound *ſterling*, doth expreſſe 3. s. as will be manifeſt by the 15th. and 8th. *Rules* of the 7th. Chapter.

XXIX. *The things expreſſed by broken numbers are principally the parts or fractions of money, waight, meaſure, time, and things accompted by the dozen.* Of the three firſt of theſe, there are infinite kindes and varieties according to the diverſity of the ſeverall *Common-wealths*, in which they are uſed, all which here to produce were both endleſſe and needleſſe: wherefore we

intend here to treat onely of ſuch *money*, *waights* and *meaſures*, as are uſed in this Kingdome, being indeed onely neceſſary to be known for our preſent purpoſe.

The Fractions.

XXX. *The leaſt part or fraction of money uſed in England is a farthing, from whence is produced this table following.*

1. Of Engliſh money.

1. *Farthing.*		1. *Farthing.*
4. *Farthings.*	*makes*	1. *Penny.*
12. *Pence.*		1. *Shilling.*
20. *Shillings.*		1. *Pound ſterling.*

In this Table you may obſerve a pound *ſterling*, being eſteemed an *Integer*, is divided into 20 parts or *ſhillings*, ſo that one *ſhilling* is a broken number of a pound *ſterling* and thus written $\frac{1}{20}$ l. that is, one twentieth of a pound *ſterling*; alſo 7 *ſhillings* are $\frac{7}{20}$ l. Likewiſe a *ſhilling* being divided into 12 parts or *pence*, one *penny* is $\frac{1}{12}$ s that is, one twelfth of a *ſhilling*; or $\frac{1}{12}$ of $\frac{1}{20}$ l that is, one twelfth of one twentieth of a pound *ſterling*: Laſtly, a *penny* being divided into 4 parts or *farthings*, one *farthing* is $\frac{1}{4}$ d. that is, one fourth of a *penny*, or $\frac{1}{4}$ of $\frac{1}{12}$ s. that is, one fourth of one twelfth of a *ſhilling*, or $\frac{1}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ l. that is, one fourth of one twelfth of one twentieth of a

pound

pound *ſterling*. Now albeit the true and naturall way of expreſſing broken numbers, is by their numerators and denominators, as before, yet the broken numbers or *known parts* of money, waight, meaſure, &c. are ordinarily (for more convenient operation) expreſſed like *Integers*, as may appear by the 12th *rule* of the 2 Chapter, and the 5th *rule* of the third Chapter: So if you were to expreſſe in figures thirteen ſhillings five pence half penny farthing, the ordinary way to ſet them down is briefly *thus*, 13-05-ob. qu. or *thus*, 13. s. 05. d. 3. f. or *thus*, oc1 13. 05. 3f. that is, no pounds, thirteen ſhillings five pence, three farthings, but the ſaid thirteen ſhillings five pence three farthings, being diſtinctly conſidered as Fraons of a pound *ſterling* will be properly written *thus*, viz.

13 *ſhillings* are thirteen twentieths of a pound *ſterling*, and written *thus*, —— $\frac{13}{20}$ l.

5 *Pence* are $\frac{1}{12}$ of $\frac{1}{20}$ of a pound *ſterling*, that is (as will appear by the 15th and 3d rules of the 7th Chapter) one fourtie eighth of a pound *ſterling*, and written *thus*, —— $\frac{1}{48}$ l.

3 *Farthings*

3 *Farthings* are $\frac{3}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound *ſterling*, that is (as will appeare by the 15th and 3 rules of the 7th Chapter) one three hundred and twentieth of a pound *ſterling*, and written *thus*, ——— = $\frac{1}{320}$ l.

Vide Stat. de Compoſitione ponderum. 51 *Hen.* 3.

XXXI. *The leaſt Fraction of waight uſed in England is a grain, that is, the waight of a grain of wheat well dried and gathered out of the middle of the eare, whereof* 32 *make a penny waight, and* 20 *penny waight make an Ounce Troy.*

31 *E.* 1. *v.* Raſt. weights. 7. & 8. 12 *H.* 7. 5.

But here obſerve, that albeit by the Statutes quoted in the margent, the waight of 32 ſuch grains of wheat make but a *penny waight*, yet the waight thereof being once diſcovered by 32 ſuch grains, the ſaid penny waight (being the twentieth part of an Ounce *Troy*) is uſually ſubdivided into 24 parts onely, called alſo *Grains*, as appears by the inſuing *Table*.

1. *Graine*

1 *Graine*		1 *Graine.*
24 *Graines*		1 *Penny waight.*
20 *Penny w.*		1 *Ounce Troy.*
12 *Ounces. Troy.*		1 *Pound Troy.*
14 *Ounc.* 12 *pen. Troy.*		1 *Pound Averdupois.*
14 *Pounds Averd.*	*waight makes*	1 *Halfe quarter of an Hundred.*
28 *Pounds*		1 *Quarter of an Hundred.*
56 *Pounds*		1 *Halfe of an hundred.*
112 *Pounds*		1 *C. That is, An Hundred.*
5 *Hundred*		1 *Hogſhead waight.*
10 *Hundred*		1 *Halfe of a Tun.*
20 *Hundred*		1 *Tunne.*

XXXII. *You may obſerve by the Table aforegoing, that there are two kindes of waight uſed in England, viz. Troy and Averdupois waight.*

XXXIII. *The pound Troy conſiſteth of twelve ounces Troy, each ounce being again divided into twenty penny waights, and each penny waight into foure and twentie grains*: wherefore here a pound *Troy* being counted the *Integer*, the ounces, penny waights 2. Of Troy waight.

waights, and grains are taken as *fractions* thereof; ſo one ounce *Troy* is written *thus*, $\frac{1}{12}$lb. that is, one twelfth of a pound *Troy*: Alſo one penny waight is $\frac{1}{20}$ ounce, that is one twentieth of an ounce *Troy*, or $\frac{1}{20}$ of $\frac{1}{12}$lb. that is, one twentieth of one twelfth of a pound *Troy*. Laſtly, one grain is $\frac{1}{24}$p. that is, one foure and twentieth of a penny waight *Troy*, or $\frac{1}{24}$ of $\frac{1}{20}$ ounce, that is, one foure and twentieth of one twentieth of an ounce *Troy*. or $\frac{1}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ lb. that is, one foure and twentieth of one twentieth of one twelfth of a pound *Troy*. So 9 ounces, 8 penny waight and 16 grains being propounded to be written properly as fractions of a pound *Troy* are expreſſed *thus*:

9 *Ounces* are $\frac{9}{12}$ of a pound *Troy*, that is (as will appeare by the 3d. *rule* of the 7th chapter.) —— $\frac{3}{4}$lb.

8 *Penny waight* are $\frac{8}{20}$ of $\frac{1}{12}$ of a pound *Troy*, that is (as will appear by the 15th and 3d *rules* of the 7th Chapter.) —— $\frac{2}{30}$lb.

16 *Grains* are $\frac{16}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ of a pound *Troy*, that is (as will appear by the 15th and 3d *rules* of the 7 Chapter.) —— $\frac{2}{360}$lb.

Or

Or briefly *thus*, (after the manner of *Integers* or whole numbers) 9. Ounces 8. p. 16. gr. or thus, 0. 9. 8, 16. that is, no pounds, 9 ounces, 8 penny waight and 16 grains.

Now this *Troy waight* ſerveth onely to weigh bread, gold, ſilver and Electuaries. And here obſerve alſo by the way, that *Troy waight* regulateth and preſcribeth a form how to keep the money of *England* at a certain *Standard*, for about two hundred yeares before the Conqueſt, *Osbright* a Saxon being then King of *England* cauſed an ounce *Troy* of ſilver to be divided into twentie peeces at the ſame time called *pence*; and ſo an *ounce* of ſilver at that time was worth no more then *twenty pence* or one ſhilling eight pence, which continued at the ſame value untill *Henry* the ſixth his time, who (in regard of the inhauncing of moneys in forain parts) valued the ſame at *thirty pence*, ſo that then there were accordingly thirty peeces made out of the *ounce*, and the old peeces went then for *three halfe pence*, untill the time of *Edward* the fourth, who valued the *Ounce* at *fourty pence*, and then the old peeces went for two pence a peece. After this *Henry* the eighth, valued the *Ounce* of ſterling ſilver at *fourty five pence*, which value continued untill Queen

Malynes Lex mercat. pag. 49.

Malynes ibid. pag. 252.

Queen *Elizabeths* time, who valued the ſame old pence at *three pence* the peece: ſo that all *three pences*, coyned by the ſaid Queene, weighed but a penny waight, and ſixe pence two penny waight; and ſo in like manner the ſhilling and other peeces accordingly; which made the ounce *Troy* of ſilver to be valued at *ſixtie pence* or five ſhillings, as it now remains at this day without alteration.

XXXIV. *A pound Averdupois is compoſed of* 14 *Ounces*, 12 *pen. troy.* And this *waight* ſerveth to weigh all kinde of Groſſery ware, as alſo Butter, Cheeſe, Fleſh, Tallow, Wax, and every other thing, which beareth the name of *Garbell*, and whereof iſſueth a refuſe or waſte:

Malynes Ibid. pag. 49.

3. Of Averdupois great waight.

XXXV. *Averdupois waight is either greater or leſſe.*

XXXVI. *The greater is, when an Hundred, conſiſting of* 112 *pound Averdupois, is the Integer, being ſubdivided firſt into foure quarters, and each quarter into eight and twentie pounds: again each pound into foure quarters, or if you will be more exact, into ſixteen ounces, and if you pleaſe, each ounce into foure quarters*; and here the quarters, pounds, ounces and quarters of ounces are the parts or fractions of an hundred;

dred: ſo half an hundred, ſeventeen pounds, ſeven ounces, and a quarter, being propounded to be written properly as *fractions* of an hundred, will be thus expreſſed:

Halfe an *hundred* is, ——— $\frac{1}{2}$C

17 *Pounds* are $\frac{17}{28}$ of $\frac{1}{4}$ of an hundred, that is, (as will appear by the 15 *rule* of the 7 Chapter.) ——— $\frac{17}{112}$C

7 *Ounces* are $\frac{7}{16}$ of $\frac{1}{28}$ of $\frac{1}{4}$ of an hundred, that is, (as will appear by the 15 and 3 *rules* of the 7 Chapter.) ——— $\frac{1}{256}$C

One *quarter* of an Ounce is $\frac{1}{4}$ of $\frac{1}{16}$ of $\frac{1}{28}$ of $\frac{1}{4}$ of an hundred, that is, (as by the 15 *rule* of the 7 Chapter will be manifeſt.) — $\frac{1}{7168}$C

Or briefly thus (after the manner of *Integers*) 0. 2. 17. 7. 1. that is, no hundreds, two quarters of an hundred, ſeventeen pounds, ſeven ounces and one quarter of an ounce.

XXXVII. *The leſſe is, when a pound is the Integer, each pound being ſubdivided into ſixteen ounces, and each ounce again into ſixteen drammes, and if you pleaſe, each dramme into foure quarters*: and in this

4 Of Averdapois little waight.

thls the ounces, drams and quarters are the parts or *fractions* of a pound *Averdupois*: so 14 ounces 5 drammes and a quarter being propounded, to be written as *fractions* of a pound *Averdupois*, will bee thus expresſed.

14 *Ounces* are $\frac{14}{16}$ of a pound *Averdupois*, that is (as wil be manifeſt by the 3 *rule* of the 7 chap.) $\frac{7}{8}$ lb.

5 *Drams* are $\frac{5}{16}$ of $\frac{1}{16}$ of a pound *Averdupois*, that is, (as will appear by the 15 *rule* of the 7 Chapter.) $\frac{5}{256}$ lb.

One *quarter* of a dram is $\frac{1}{4}$ of $\frac{1}{16}$ of $\frac{1}{16}$ of a pound *Averdupois*, that is, (as will apear by the 15 *rule* of the 7 Chapter.) $\frac{1}{1024}$ lb.

Or briefly thus, after the manner of *Integers*, o. 14. 5. 1. that is, no pounds, 14 ounces, five drams and a quarter.

XXXVIII. *The meaſures uſed in* England *are either of capacitie or length.*

XXXIX. *The meaſures of capacity are thoſe which are produced from waight, and they are either liquid or drie.*

5 Of liquid meaſures.

XL. *The liquid meaſures are thoſe, in which all kind of liquid ſubſtances are meaſured, and they are expreſſed in the* Table *following.*

1 *Pound*

1 Pound of wheat Troy w.	makes	1 Pinte
2 Pints		1 Quart.
2 Quarts		1 Pottle.
2 Pottles		1 Gallon. (Herring.
8 Gallons.		1 Firkin of Ale, ſope,
9 Gallons		1 Firkin of Beere.
10 ½ Gallons		1 Firkin of ſalmõ, or
2 Firkins		1 Kilderkin. (Eeles
2 Kilderkins		1 Barrell.
42 Gallons		1 Tierce of Wine.
63 Gallons		1 Hogſhead.
2 Hogſheads		1 Pipe or Butt.
2 Pipes, or Butts		1 Tun of Wine.

Vide 12. H. 7. cap. 5.

XLI. *Dry meaſures are thoſe, in which all kinde of dry ſubſtances are meted*, as graine, ſeacole, ſalt, and the like; their Table is this that followes. 6. Of drie meaſures.

1 Pinte	makes	1 Pinte.
2 Pints		1 Quart.
2 Quarts		1 Pottle.
2 Pottles		1 Gallon.
2 Gallons		1 Pecke.
4 Pecks		1 Buſhel land meaſure:
5 Pecks		1 Buſhel water meaſure
8 Buſhels		1 Quarter.
4 Quarters		1 Chalder.
5 Quarters		1 Wey.

7. Of long measures. *Vide* 33. *Edw.* 1. & 25 *Eliz.*

XLII. *Long measures are expressed in the Table following;*

3 *Barley cornes*		1 *Inch.*
12 *Inches*		1 *Foot.*
3 *Foot*		1 *Yard.*
3 *Foot* 9 *Inches*	*makes*	1 *Ell.*
6 *Foot*		1 *Fadome.*
5½ *yards*		1 *pole or yearch*
40 *Poles*		1 *Furlong.*
8 *Furlongs*		1 *English mile.*

8. Of Time.

XLIII. *A Table of Time is this, that follows:*

1 *minute*		1 *minute.*
60 *minutes*		1 *houre.*
24 *houres*		1 *day naturall.*
7 *dayes*	*makes*	1 *weeke.*
4 *weekes*		1 *moneth of* 28 *dayes.*
13 *moneths*		
1 *day and*		1 *yeare.*
6 *houres*		

Howbeit in ordinary computations of *Time*, the whole yeare consisting of 365. dayes, is divided into twelve moneths, each moneth (accounting one moneth with another) containing 30 $\frac{5}{12}$ daies, that is 30. daies and five twelves of a day: And here observe,

ſerve, that the fractions of *meaſures and time* are likewiſe written and pronounced, as thoſe of *money and weight*, their reſpective termes being obſerved.

XLIV. *Of things accounted by the dozen, A groſſe is the Integer conſiſting of* 12 *dozen, each dozen containing again twelve particulars*; And therefore here the dozens and particulars are parts, or *fractions* of a Groſſe: So if ſeven dozen and five points were propounded, to be written properly as fractions of a Groſſe, they are to bee thus expreſſed: 9. Of things accounted by the dozen.

7. *Dozen* are $\frac{7}{12}$ G.

5 *Points* are $\frac{5}{12}$ of $\frac{1}{12}$ of a Groſſe, } that is (as will be manifeſt by the } $\frac{5}{144}$ G.
15th *Rule* of the 7th chap. }

Or briefly *thus*, (after the manner of *Integers*) 7 doz. 5 points, or *thus* 0. 7. 5. that is, no Groſſe, 7 dozen and 5 points.

XLV. *An improper broken number is that, whoſe Numerator is greater then the Denominator*; As $\frac{17}{12}$ foot, that is, foure and fifty *twelves* of a foot: and indeed a broken number of this kind may well bee ſurnamed *Improper*, becauſe it will not admit the definition of a true broken number, being alwaies greater then an intire *unity*: So $\frac{17}{12}$ foot is after *Reduction* 4 intire foot,

and $\frac{6}{12}$ that is, ſix inches, as ſhall further appeare hereafter.

A mixt number.

XLVI. *A mixt number is that which beſides the Integers, or intire Unities, of which it conſiſts, hath alſo a broken number annexed:* ſo if you would expreſſe in figures a length of a piece of timber, that containes twelve foot, and five and twenty hundreds of a foot, you are to write it *thus*, 12 $\frac{25}{100}$. In like manner, 24. l. 13. s. 5.d. 3.f. that is, 24. intire pounds, 13. ſhillings, 5. pence, 3. farthings, are *thus* expreſt, 24. s. $\frac{647}{960}$ or briefly (as before) *thus*, 24. l. 13. s. 05. d. 3. f. 0. yet *thus*, 24. 13. 05. 3.

Vide ſupra Rule 28.

XLVII. *A mixt number hath two parts, the whole, and the broken.*

XLVIII. *The whole part is, that compoſed of the Integers or intire unities*; as in the laſt examples, 12. & 24.

XLIX. *The broken part is the Fraction annexed*, as $\frac{25}{100}$ and $\frac{647}{960}$.

L. *When the Fraction annexed is a Decimall, you may expreſſe it without the Denominator by fixing a point betweene the whole and broken parts of the number propounded*, ſo 12 $\frac{25}{100}$ may be *thus* expreſt, 12. .25. and 16. $\frac{5}{100}$ thus 16. 05.

CHAP.

CHAP. 2.

Of Addition.

I. *ARithmetique is either Naturall or Artificiall.*

II. *Naturall, which is performed by the numbers themſelves; and this is either Poſitive, or Negative.*

III. *Poſitive Arithmetique is that, which is wrought by certaine and infallible numbers at firſt propounded; and this is either ſingle or comparative.*

IV. *Single, which is wrought by Numbers conſidered alone without having Relation one to another.*

V. *The parts of ſingle Arithmetique are* 1 *Numeration,* 2 *the Extraction of Roots.*

VI. *Numeration is that which by certaine known numbers propounded, diſcovereth another Number unknown.*

VII. *Numeration hath foure ſpecies,* viz. *Addition and Subtraction; Multiplication and Diviſion.* Ramus Arithm. lib. 1. cap. 2. prop. 3. & 4. & 6. prop. 2.

VIII. *Addition is that by which divers numbers are added together, to the end that the ſumme or totall may be diſcovered.*

Addition 1. Of whole Numbers.

IX. *In addition place the numbers given one above another in ſuch ſort, that the like degrees may ſtand in the ſame ranke:* that is, units above units, tenths above tenths &c. So the numbers 1213, and 462, being given to bee added together, you are to order them, as you ſee in the Margent:

1213
462

X. *Having thus placed the numbers, and drawne a line under them, adde them together, beginning with the units firſt,* and ſaying thus, 2 and 3 make 5, which write under the line in the rank of *units:* then 6 and 1 makes 7. which write in the next place towards the left hand in the rank of *Tenths,* and ſo proceed till you have finiſhed the whole addition.: which done, the *ſumme* of theſe two given numbers is 1675 and the intire *operation* will ſtand thus;

1213
462
1675

In like manner the numbers 2315, 7423, and 141, being given, their *ſumme* is 9879, and the *operation* thereof will ſtand thus:

2315
7423
141
9879

XI. *When the ſumme of the figures of any of the ranks exceeds ten, place downe under the ſame ranke the exceſſe, and for each ten that it ſo exceeds carry an unit in your mind, and adde it to the figures*

of

of the next ranke towards the left hand: So the numbers 54937, 9878, and 394, being given to be added together, the *operation* will ſtand thus; for 4, 8, and 7, make *nineteen*, wherefore I ſet down 9, and carrying in minde 1 for the *ten*, that it exceeds, I ſay, 1, and 9, (9 being the firſt figure of the next rank) make *ten*, which being added to 7 and 3, the other figures of the ſame rank, the whole ſumme of them is *twenty*, wherefore ſetting down a cypher under the line in that rank, (becauſe the exceſſe above two *tens* is nothing) I cary 2 to the next rank, and ſo proceeding till the whole *operation* be finiſhed, I finde the *ſumme* of the three numbers given to bee 65209, as in the example.

54937
9878
394
65209

XII. *When the numbers propounded to be added have divers denominations, you muſt begin with the leaſt firſt, and when the ſum of any of the denominations amounts to an Integer, adde it to the next Integers upon the left hand:* So theſe ſeverall ſummes 24, l. 13, s. 5, d. 3, f. *Item*, 12, l. 0, s. 8, d. and 5, l. 18, s 0, d. 2, f. being propounded, their totall ſumme is 42, l. 12, s. 2, d. 1, f.

2. Of Numbers which have divers denominations. See the latter part of the 30. Rule of the Ch. aforegoing.

l.	s.	d.	f.
24.	13.	05.	3.
12.	00.	08.	0.
05.	18.	00.	2.
42.	12.	02.	1.

For 3 and 2 farthings make *one penny farthing*, wherefore ſetting downe one under the denomination of farthings, I carry one *penny* to the denomination of pence: then I ſay, 1,8,and 5, make 14, which is 1 ſhilling 2 pence,wherefore writing 2 under the denomination of pence I likewiſe carry 1 *ſhilling* to the denomination of ſhillings: In like manner, adding the ſaid 1 ſhilling unto 18 ſhillings and 13 ſhillings, the ſumme will be found 1 pound and 12 ſhillings, wherefore ſetting down 12 under the denomination of ſhillings, I carry 1 *pound* unto the denomination of pounds, and proceeding with the pounds according to the 10th and 11th *Rules* of this Chapter, at laſt I finde the *totall* of the three ſummes propounded to be 42, l. 12, s. 2, d. 1, f. as aforeſaid.

In

In like manner 3, lb. 5, ounc. 19, p. 15, gr. *Item* 2 lb. 0, ounc. 3, p. 7. gr. *Item* 0, l. 10, ounc. 6, p. And 0, lb 9, ounc. 0, p. 17, gr. being given, their ſumme is 7, lb. 1, ounce, 9, p. 15, gr.

03.	05.	19.	15.
02.	00.	03.	07.
00.	10.	06.	00.
00.	09.	00.	17.
07.	01.	09.	15.

Chap. 3.

Of Subtraction.

Subtraction. 1. Of whole Numbers.

I. *Subtraction is that, by which one number is taken out of another, to the end that the reſidue or remainder may be known, which remainder is alſo called the Difference.*

II. *The number out of which the ſubtraction is to be made, muſt be greater, or at leaſt equall with the other:* As you may ſubtract, 4347, or 9478, out of 9478, ſo can you not ſubtract 9478, out of 4347.

III. *In ſubtraction rank your numbers and begin as in Addition,* that is, with the *units* firſt: So the numbers 9478, and 4347, being given to be ſubtracted the one out

out of the other, I order them as in the Margent: then proceeding to the *ſubtraction* I ſay 7 out of 8 there *remaines* one, which I place in the ſame rank under the line. In like manner 4 being taken out of 7, the *remainder* is 3, which likewiſe I ſet under the line in the next rank: And thus finiſhing the whole *operation* the *remainder* of 4347, taken out of 9478, will be found 5131, or the difference betweene 4347 and 9478, is 5131. As in the *example.*

9	4	7	8
4	3	4	7
5	1	3	1

IV. *When any of the figures of the number given to be ſubtracted is greater then the figure, out of which it is to be ſubtracted, you muſt borrow ten of the next ranke towards the left hand: and then the figure of which they are ſo borrowed muſt afterwards be eſteemed an Unit leſſe: wherefore in this caſe keeping one in your minde add it to the next figure of the number given to be ſubtracted, and deducting all out of the figure above it, proceed in like ſort till you have finiſhed the whole operation.*

Example, 4538, being given to be ſubtracted out of 8203, having placed them as before, *I ſay*, 8 out of 3, that cannot bee, wherefore borrowing ten of the next rank,

I ſay,

I ſay, 8 out of 13, there *remaines* 5, then writing 5 under the line: and carrying 1 in my mind *I ſay*, 1, and 3, are 4, 4, out of nothing, that cannot bee, but 4 out of 10, there *remaines* 6, which I write likewiſe under the line, and ſo proceeding till the whole operation be finiſhed, it will ſtand as you ſee it in the example.

	8203
	4538
	3665

V. If the numbers propounded have divers denominations, when any of the parts of the greater number are leſſe then the parts of the leſſe number ſubſcribed, ſubduct the parts of the leſſer number from the parts of the greater number increaſed with an Integer, of the next ſuperiour denomination, and keeping one (that is, the Integer borrowed) in your minde, adde it to the next place of the number given to be ſubtracted as before: So 12, l. 0, s. 8, d. being deducted out of 24, l. 13, s. 5, d. 3, f. the remainder is 12, l. 12, s. 9, d. 3, f. for 0 being deducted out of 3, f. there *remains* 3, f. then becauſe 8, pence cannot be taken out of 5 pence, I borrow 1, s. of the next *denomination*,

2. Of Numbers having divers denominations.

24.	13.	05.	3.	
12.	00.	08.	0.	
12.	12.	09.	3.	

nation, which makes the 5, d. 17, d. then *I ſay*, 8, d. out of 17 d. there *remaines* 9, d. wherefore writing 9 under the denomination of pence, I proceed to the next *denomination*, and *ſay*, 0, and 1 ſhilling (that is the 1 ſhilling which was borrowed) make 1 ſhilling, which being deducted out of 13 ſhillings, the *remainder* is 12, which I ſubſcribe under the *denomination* of ſhillings: Laſtly, deducting 12, l. out of 24, l. at laſt I finde, if *A.* being indebted to *B.* in 24, l. 13, s. 5, d. 3, f. hath diſcharged thereof 12, l. 0, s. 8, d. there *remaines* yet undiſcharged 12, l. 12, s. 9, d. 3, f.

The proof of Addition and Subtraction.

VI. *Addition is proved by Subtraction, and Subtraction by Addition:* For having added divers numbers together, if you *ſubtract* one of them out of the ſumme, the *remainder* will be equall to the reſt, as you may obſerve by the *Examples* following:

Here in the firſt *example* 462, being deducted out of 1675 the ſumme, the *remainder* is 1213 which is the ſame with the other number given to be added: So in the other *example* 394, being *ſubtracted* out of 65209, the *remainder* is 64815, which is e-

1213	
462	
1675	
1213	
54937	
9878	
394	
65209	
64815	

quall

quall to the ſumme of 54937 and 9878, the other numbers given to be added.

In like manner is *Subtraction* proved by *Addition*: for if you adde the number given to be ſubtracted, and the remainder together, the ſumme will be equall to the number, out of which the ſubtraction is made, as appeares by theſe *examples.*

9478	8203
4347	4538
5131	3665
9478	8203

CHAP. IV.

Of Multiplication.

I. *MUltiplication is that by which we multiply two numbers the one by the other, to the end their product may be diſcovered.*

II. *Multiplication hath three parts, the Multiplicand, the Multiplicator, and the Product.* The parts of Multiplication.

III. *The Multiplicand is the number given to be multplied.*

IV. *The*

IV. *The Multiplicator is the number by which the multiplicand is multiplied.*

V. *The Product is the number produced by the Multiplication.* So if 5 bee given to bee *multiplyed* by 3, the third number *produced* is 15, for 3 times 5, makes 15. and here 5 is the Multiplicand, 3 the Multiplicator, and 15 the product.

VI. *Multiplication is single or compound.*

Single Multiplication.

VII. *Single Multiplication is, when the multiplicand, and multiplicator consist each of them of one onely figure*, as in the last *Example*; In like manner if you *multiply* 9 by 5. the *product* is 45. this is likewise *single* Multiplication: now the severall varieties of *single* Multiplication are well expreſt in the *Table* following, usually called *Pythagoras* Table.

The

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The use of the Table is this, Having one figure given to be *multiplyed* by another, to know the *product* of them, find the *multiplicand* in the top of the Table, and the *multiplicator* in the first column thereof towards the left hand; this done, in the angle of *Position* just against those two figures you shall finde the *Product*. So 9 being given to be *multiplied* by 5, I find 9 in the top of the Table, and 5 in the first column toward the left hand, then in the angle of *Position*, (*viz.* in the first column towards the right hand) just against those figures I finde 45, which is the *product* required: And the particular varieties of this Table ought

ought to be learned by heart (that is, a man must know by heart the *product* of any *single* multiplication) before he can be able to work readily *compound* multiplication, as shall further appear hereafter.

Compound Multiplication.

VIII. *Compound multiplication is when the multiplicator and multiplicand either one or both consist of moe figures then one.*

IX. *In Compound multiplication when the numbers given end with significant figures, place them as in Addition, and Subtraction.* So 1232 being given to bee *multiplied* by 3, place them thus; then proceeding to the multiplication *say thus*, three times two is six, which write under the line in the ranke of your *multiplying* figure; Again *say* three times three is nine, which write likewise under the line in the next rank, and so proceed till you have finished the whole *multiplication*, which will then stand as you see it in the margent.

1232	
3	
1232	
3	
3696	

X. *When the multiplicator consists of moe figures then one, for as many figures as it hath, so many severall products must be subscribed under the line, which at last being added into one summe, gives you the totall product of all.*

So

So 1232 being given to bee *multiplied* by 23, the operation thereof wil ſtand thus; for 1232 being *multiplied* by 3, the *product* is 3696: again 1232 being *multiplyed* by 2, the *product* is 2464, which ſeverall *products* ſtanding in their due order, (that is the laſt figure of each *product* under his reſpective *multiplying* figure) and added together produce 28336, the *product* required: In like manner 1321 being given to be *multiplied* by 123, the *product* is 162483 and the operation will ſtand as you ſee it in the *Margent*.

1232	
23	
3696	
2464	
28336	
1321	
123	
3963	
2642	
1321	
162483	

XI. *When the product of any of the particular figures exceeds ten, place the exceſſe under the line as before, and for every ten that it ſo exceeds, keep one in minde to bee added to the next rank.*

Example, 3473 being given to bee *multiplied* by 64, the worke will ſtand thus; for 4 times 3 being 12, I write 2 under the line, and reſerve 1 for the *ten*, that it exceeds, to bee added to the next rank; Then I *ſay* 4 times 7 is 28, unto which if I adde 1

3473	
64	
13892	
20838	
222272	

1 which I kept in mind, the whole is 29. wherefore ſubſcribing 9 in the next rank under the line, and carrying two in mind for the two *tens*, that it exceeds, I proceed to perform the reſt of the work, as you ſee it in the *example*.

XII. *When the numbers given to be multiplied, do end, or both of them end with cyphers, place their firſt ſignificant figures towards the right hand one under another, and when the multiplication of the ſignificant figures is finiſhed, annexe all the cyphers after the number produced by the multiplication, which will give you the true product demanded*: As appears by the examples following:

43125	43100
1500	15000
215625	2155
43125	431
64687500	646500000

XIII. *When in the Multiplicator, cyphers are included between ſignificant figures, multiply by the ſaid ſignificant figures, neglecting ſuch cyphers or cypher, and obſerve to ſet each particular*

lar Product in its due place according to the 10th. *rule of this Chapter:* Examples hereof, are these following:

3634	56324
205	20006
18170	337944
7268	112648
744970	1126817944

XIV. *When a number is given to be multiplied by a number, that consists of an unit in the first place towards the left hand, and nothing but cyphers towards the right (such as are* 10. 100. 1000. 10000. *&c.) the Multiplication is performed by annexing the cyphers of the Multiplicator after the figures of the Multiplicand:* So if 4057 were given to bee *multiplied* by 10000, the *product* will be found 40570000.

Continuall Multiplication.

XV. *When two numbers then two are given to bee multiplied together, they are said to bee multiplied continually, and this kind of multiplying is termed Continuall multiplication.*

So if 4, 18, and 22, were given to be *multiplied* continually; first 18 *multiplied* by 4, *produceth* 72, which being multiplied by 22, (the third number) *produceth* 1584, the last *product* or number required; the worke ſtands as in the *margent*.

18	
4.	
72	pr. 1.
22	
144	
144	
1584	pr. 2.

Chap. V.

Of Diviſion.

I. *Diviſion is that by which wee diſcover how often one number is contained in another, to the end we may find the Quotient.*

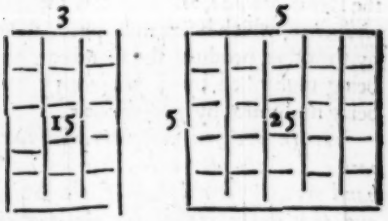
The parts of Diviſion. II. *Diviſion hath three parts, the Dividend, the Diviſor, and the Quotient.*

III. *The Dividend is the number given to be divided.*

IV. *The Diviſor is the number, by which the Dividend is divided.*

V. *The Quotient is the number produced by the Diviſion*: So if 15 were given to be *divided* by 5, the number produced would

would be 3. for 5 is found to be three times in 15, and here 15 is the *Dividend*, 5 the *Diviſor*, and 3 the *Quotient*. The reaſon or demonſtration both of *Diviſion* and *Multiplication* is well expreſt by the *Diagrammes* following:



In the firſt of which you may obſerve, that the whole content comprehends 15 little *ſquares*, and therefore here 15 is the *Dividend*, 5 (one of the ſides) the *Diviſor*, and 3 (the other ſide) the *quotient*; or *vice verſa*, 15 is the *Dividend*, 3 the *Diviſor*, and 5 the *quotient*: for if it be demanded, how often 5 is in 15, the *Anſwer* is 3. or it being demanded how often 3 is in 15, the *Anſwer* is 5. becauſe as the one way when you conceive five of the little *ſquares* to be in a rank, the number of the ranks is 3,

ſo the other way when you place three in a rank, the number of the ranks will then be found 5. Likewiſe in the other *Diagramme*, the whole content 25 is the *Dividend*, 5 the *Diviſor*, and 5 the *quotient*: for 5 is found five times in 25. Again, obſerve that in *Multiplication* one of the ſides is the *Multiplicand*, and the other the *Multiplicator*, which being multiplied, the one by the other produce the Content: So 5 being multiplied by 3 *produce* 15, and 5 being multiplied by 5 *produce* 25.

The way how to work Diviſion.

VI. *In Diviſion, make a crooked line at each end of the dividend, that on the left hand ſerving for the place of the diviſor; and that on the right, for the quotient; then diſtinguiſh by a point, ſo many of the formoſt places of the dividend, as will contain the diviſor; which number ſo ſet apart, may (for diſtinction ſake) be called the dividuall:* So 2471862 being given to bee divided by 38, let a point under 7, not under 1, becauſe fewer places will contain the *diviſor*, not under 4, becauſe 24 is leſſe then the *diviſor*, ſo is 247 the *dividuall*.

38)2471862(

VII. *Having thus prepared the numbers, aske how often the diviſor is contain-*

ed

ed in the dividuall, and place, that which anſwers the queſtion in the quotient, then multiply the diviſor by that particular quotient, and ſubtract the product from the dividuall, ſetting down the remainder.

Thus aske how often 38 is contained in 247, and ſince to anſwer this queſtion, (and ſuch like) there is a neceſſity of triall, it will be requiſite that you fitly begin your triall, viz. If the *diviſor* and *dividuall* conſiſt of equall places, aske how often the firſt figure of the *diviſor* towards the left hand, is contained in the firſt figure of the *dividuall* towards the left, but if the *dividuall* conſiſt of one place more then the *diviſor* (as here it doth) aske how often the firſt figure of the *diviſor*, is contained in the two formoſt places of the *dividuall*, viz. Aske how often 3 is contained in 24, ſo the anſwer will be 8 times, which ſhewes that 38 cannot be found in 247 more then 8 times, and therefore begin the triall with 8, then multiplying 38 by 8 the product is 304, which being greater then 247, make triall with 7; ſo multiplying 38 by 7, the product is 266, which being yet greater then 247, make triall with 6; ſo multiplying 38 by 6, the product is 228, which being leſſe then 247, ſhewes, that 38 may

bee found 6 times in 247, therefore place 6 in the *quotient* and ſet down the ſaid product 228 under the *dividuall* 247; then draw a line under the product 228 and ſubduct the ſame from the *dividuall* 247, ſo is the remainder 19, and the worke will ſtand as in the *Margent*.

38)2471862(6
228
19

VIII. *Set a point under the next place of the dividend, and tranſcribe the figure or cypher ſtanding in that place, after the remainder, which gives you a new dividuall*; So 1 being tranſcribed after 19, the *dividuall* is 191, and the work will ſtand as in the *Margent*.

38)2471862(6
228
191

IX. *Renew the queſtion and proceed according to the 7th. rule of this Chapter*, viz. ſeek how often 38 is found in 191, and beginning the triall at 6, becauſe 3, (the firſt figure in the *diviſor*) is contained 6 times in 19, (the two formoſt places of the *dividuall*) multiply 38 by 6, ſo will the product be 228, which being greater then the *dividuall* 191, make triall with 5, and ſo the product of 38 multiplied by 5, will

will be found 190, which being leſſe then 191, ſhewes, that 38 may bee found 5 times in 191, therefore place 5 in the *quotient*, and ſet down the product 190, under the *dividuall* 191, then drawing a line, and ſubducting 190 from 191, the remainder is 1, and the work will ſtand as in the *Margent*.

```
38)2471862(65
   228
   ---
   191
   190
   ---
     1
```

X. *Proceed according to the* 8th. *rule of this Chapter*: ſo will the new *dividuall* be found 18, and the work will ſtand as you ſee in the *Margent*.

```
38)2471862(65
   228
   ---
   191
   190
   ---
    18
```

XI. *Repeat the queſtion*, viz. aske how often 38 is found in 18, and here becauſe the *diviſor* 38, is leſſe then the *dividual* 18, place a cypher in the *quotient* (which is to be done in like manner as often as the *diviſor* is greater then the *dividuall*)

```
38)2471862(650
   228
   ---
   191
   190
   ---
   186
```

then

then proceed according to the 8th. rule of this Chapter; so will the new *dividuall* be found 186, and the worke will stand as in the *Margent*.

XII. *Repeat the question, and proceed in every respect as before, untill the whole work be finished*, which will stand as in the *margent*, and the *quotient* required will be found 65049; And here observe, that although the first figure of the *divisor*, may sometimes bee found more then 9 times in the correspondent part of the *dividuall*, yet the whole *divisor*, cannot bee found more then 9 times, in the whole *dividuall*, and therefore you need never begin the triall above 9, in any of the operations, so in the last operation of this Example, although 3 might be found 11 times in 34, yet 38 will not be found more then 9 times in 342.

```
38)2471862(65049
   228
   ---
    191
    190
    ---
     186
     152
     ---
      342
      342
      ---
        0
```

XIII. *So often as the question is repeated in division, so many places there must be in*

in the quotient, which may be discovered, by the number of points placed under the dividend, and so many severall operations are there in the whole worke, which you are to continue, till the last place of the dividend be transcribed.

XIV. *When after the whole worke is finished, any figures remain of the last subtraction, they are the Numerator of a Fraction, which hath the divisor for its denominator, and is to be annexed to the quotient, as the broken part thereof, which Fraction expresseth certain parts (or at least a part) of an Integer, which is alwayes of the same denomination with the quotient*: So if 83027 crownes were to be distributed amongst 343 *Souldiers*, the part allotted to each *Souldier*, would be $242\frac{21}{343}$ that is, 242 crowns, and 21 parts of a crown being divided into 343 parts; for 83027 being divided by 343, the *quotient* is $242\frac{21}{343}$, as appears by the work;

343)83027($242\frac{21}{343}$
686
1442
1372
707
686
21

But to find the value of the said $\frac{21}{343}$ of a crown, or of any other Fraction, see the 8th.

8th. Rule of the 7th. Chapter.

XV. *When the diviſor conſiſts of an Vnit in the firſt place towards the left hand, and nothing but cyphers towards the right, the diviſion is performed by cutting off ſo many places of the dividend towards the right hand, as the diviſor hath cyphers; which figures ſo cut off are the numerator of a Fraction, which hath for the denominator the diviſor given.*

So if 4720348 were given to be *divided* by 10000, the work would ſtand as in the *margent*, and the number required by the *diviſion* is $472\frac{348}{10000}$, or 472.0348 by the laſt *rule* of the firſt Chapter aforegoing.

4720348

472 0348

XVI. *When the diviſor conſiſts of any ſignificant figure or figures in the firſt place (or more of the formoſt places) towards the left hand, and nothing but cyphers towards the right, cut off ſo many places of the dividend towards the right hand, as the diviſor hath cyphers towards the right, and divide the dividend remaining on the left hand, by the remaining part of the diviſor when the cyphers are omitted, remembring after the diviſion is ended, to reſtore aſwell the cyphers to the diviſor, as the places cut off to the dividend.* So

So if 7456787 were given to be *divided* by 304000. the *quotient* would be found 24 $\frac{160787}{304000}$, for if you cut off 3 places of the *dividend* towards the right hand, (3 places becauſe the 3 laſt places of the *diviſor* are cyphers) and divide the remaining part of the *dividend*, viz. 7456 by 304, the whole part of the *quotient* will bee found 24; Alſo if unto 160 the remainder of the laſt ſubtraction, you reſtore the places of the *dividend* cut off towards the right hand, viz. 787, there will bee 160787 for the *numerator* of a *Fraction*, whoſe *denominator* is the whole *diviſor*, viz. 304000.

304|000)7456787(24 $\frac{160787}{304000}$
608
1376
1216
160787

XVII. *When the dividend is leſſe then the diviſor, place the dividend as the numerator of a Fraction, and the diviſor as denominator, ſo is ſuch Fraction the quotient ſought, the value whereof (if there bee occaſion) may be found by the* 8th. *rule of the* 7th. *Chapter.*

So if 3 pounds *ſterling* were to bee diſtributed amongſt 4 men, each mans ſhare would

would be $\frac{1}{4}$l. that is (as will be manifest by the 8th. *rule* of the 7th. Chapter) 15. shillings.

Bipartition and Tripartition.

XVIII. *Two particular species of division are Bipartition and Tripartition.*

XIX. *Bipartition (otherwise called Mediation) is division by 2.*

XX. *Tripartition is division by 3.*

XXI. *In Bipartition and Tripartition, subscribe the quotient under the dividend (or where you please) not setting down at all the Divisor.*

So 82506 being given to be halfed or divided by 2, the work will stand thus; for 2 is 4 times in 8, once in 2, 2 times in 5, and then because 1 remains of 5, which makes the place of the cypher 10; I write 5 under the cypher, (2 being 5 times in 10) And last of all I place 3 under 6, 2 being found 3 times in 6. In like manner 82506 being given to be divided by 3, do as you are directed in the other example.

82506	
41253	
82506	
27502	

The proofe of Multiplication and Division.

XXII. *Division and Multiplication do interchangeably prove one another;* for in *Division* if you multiply the *divisor* by the

the *quotient*, the *Product* will be equall to the *dividend*: So in the example of the 12. *Rule* of this Chapter, 38. the *diviſor* being multiplied by 65049 the *quotient* produceth 2471862 the *dividend*: But when after the whole *diviſion* is finiſhed, any figures *remain* of the laſt ſubtraction, adde them likewiſe to the *Product*: ſo in the example of the 14th. *Rule* of this Chapter, 343 being multiplied by 242, the *Product* is 83006, unto which if you adde 21, the figures remaining, the ſumme is 83027 the *dividend*. Againe in *Multiplication*, the *Product* being *divided* by the *Multiplicator*, the *quotient* will give you the *Multiplicand*: ſo in the ſecond example of the 10th. *Rule* of the laſt Chapter, 162483 the *Product*, being *divided* by 123 the *Multiplicator*, the *quotient* gives you 1321 the *Multiplicand*.

To prove Diviſion by Addition.

Diviſion may likewiſe bee proved by Addition, for if the ſeverall products ariſing from the Multiplication of the diviſor by each particular quotient, and the remainder of the laſt ſubtraction (if there be any,) be added together in the ſame order of ranges as they are placed in the diviſion, the ſumme will be equall to the dividend.

So

So in the example of the 14th. *Rule* of this Chapter if the severall *Products* 686, 1372,686 with the *remainder* 21 be added together in the same order of ranks as they are placed in the *division*, the summe will bee found 83027, which is the same with the *dividend*, as by the operation in the *Margent* may appeare.

343) 83027 (24 $\frac{21}{343}$
6|8|6| |
1|4|4|2|
1|3|7|2|
| |7|0|7
| |6|8|6
| | |2|1
83027

Chap. VI.

Of the Reduction of Integers from one denomination to another.

The Reduction of Integers from one Denomination to another.

I. BY *denominations* are here understood the particular *Species* of Money, Waight, Measure, Time, &c. So a pound *sterling*, a shilling, a penny, a farthing, are the particular *Species* or *denominations* of money

money uſed in *England*, as may appear by the 30th. *Rule* of the firſt Chapter: alſo a pound, an ounce, a penny waight, a grain, are the particular *Denominations* of *Troy* waight, as may appeare by the 31, 32, and 33 *Rules* of the firſt Chapter: And the like is to be underſtood of *Averdupois* waight, meaſures, time, &c. whoſe particular *Species* or *denominations* are expreſſed in the *Tables* of the firſt Chapter: Now albeit, the known parts of money, waight, meaſure, &c. are properly fractions, yet (for more commodious operation) they are eſteemed and written (ordinarily) as Integers, (as may appeare by the 30. 33. 36. 37. 44 *Rules* of the firſt Chapter: alſo by the 12th *Rule* of the 2d. Chapter and the 5th. of the 3d. Chapter.) And ſo they are eſteemed in this *Rule* of *Reduction*, which ſerveth to reduce ſuch kind of whole numbers or Integers from one *denomination* to another, *viz.* a greater *denomination* into a leſſe, as pounds into ſhillings, ſhillings into pence, and pence into farthings, (and the like is to be underſtood of other *denominations*.) or elſe a leſſer *denomination* into a greater, as farthings into pence, pence into ſhillings, and ſhillings into pounds, (and ſuch like.)

To reduce Integers from a greater denomination to a leſſe.

II. *Integers of a greater denomination are reduced into Integers of a leſſe by multiplication; for if the number of Integers given, be multiplyed by the number of Integers of the denomination required, which are equall to one of the Integers given, the product is the number of Integers of the denomination required.*

So 230 pounds *ſterling* are reduced into 4600 ſhillings, for if 230 be multiplyed by 20, (the number of ſhillings which are equall to a pound *ſterling*) the product is 4600; In like manner 4600 ſhillings are reduced into 55200 pence; for if 4600 be multiplyed by 12, (the number of pence wch are equall to a ſhilling) the product is 55200. Alſo 55200 pence being multiplyed by 4, (becauſe 4 farthings make a penny) are reduced into 220800 farthings;

	230
	20
	4600
	12
	9200
	4600
	55200
	4
	220800

as by the operation in the *Margent* is manifeſt. The like is to bee obſerved in Waight, Meaſure, &c. So 345 Ounces *Troy* are reduced into 6900 penny

penny waight, and 6900 penny waight into 165600 graines, as by the operation in the *margent* is manifeſt.

345
20
6900
24
27600
13800
165600

III. *Integers of divers denominations, are reduced into the leaſt of thoſe denominations according to the laſt Rule, by deſcending orderly to the next inferiour denomination, and adding to each Product ſuch Integers (if there be any) which belong unto it.*

To reduce Integers of divers denominations into the leaſt of thoſe denominations.

So 12 pounds, 13 ſhillings and 10 pence are reduced into 3046 pence in this manner, *viz.* 12. *li.* multiplyed by 20. *s.* produceth 240 ſhillings, unto which adding 13. *s.* the ſumme is 253 ſhillings. Againe 253 ſhillings multiplyed by 12 pence, produceth 3036 pence, unto which

li. *s.* *d.*
12—13—10
20
240
13
253
12
506
253
3036
10
3045

if 10 pence be added, the ſumme is 3046 pence, as by the operation in the *margent* is manifeſt. The like is to be obſerved in waight, meaſure, time, &c. So 35 ounces 16 penny waight and 12 graines will bee reduced into 17196. graines.

To reduce Integers from a leſſer denomination to a greater.

IV. *Integers of a leſſer denomination are reduced into Integers of a greater by diviſion; for if the number of Integers given be divided by ſuch a number of the ſame Integers which are equall to one of the Integers required, the quotient is the number of Integers ſought.*

So 220800 farthings are reduced into 55200 pence; for if 220800 be divided by 4, (the number of farthings which are equall to a penny) the Quotient is 55200 pence; In like manner 55200 pence are reduced into 4600 ſhillings; for if 55200 be divided by 12, (becauſe 12 pence make a ſhilling) the Quotient is 4600 ſhillings; Laſtly, 4600 ſhillings being divided by 20, (becauſe 20 ſhillings are equall to a pound *ſterling*,) the Quotient is 230 pounds *ſterling*, which are equall to 220800 farthings firſt given; The operation will bee as followeth,

12

```
                12        20
4) 220800 (55200 (4600 (230 li.
   20        48
   20        72
   20        72
    08       000
     8
    000
```

In like manner 34268 graines *Troy*, will bee reduced into 5 pounds, 11 ounces, 7 penny waight and 20 graines *Troy*.

If the *Learner* bee desirous onely of so much *Arithmeticall* skill as may bee sufficient for the resolution of most practicall questions which will happen in ordinary affaires or commerce, he may from this Chapter proceed next of all to the 21th. Chapter treating of the *Rule* of *Three*, and therein principally observe the three first *Examples*, waving all the operations of *Fractions* as well vulgar as decimall, excepting the 8th. *Rule* of the 7th. Chapter which is very necessary in division for the finding the value of the fractionall part of the quotient, (when any happens:) But if hee desire to lay a good foundation for knowledge in the *Mathematiques*, it will be requisite that he take all in order.

Chap. VII.

Of Reduction of Fractions.

See the definitions of Fractions in the 1 Chapter.

I. The ſame parts of *Arithmetique*, *viz.* Addition, Subtraction, Multiplication and Diviſion, which have been wrought in whole numbers by the 2. 3. 4. and 5th. Chapters, are likewiſe to be performed in broken numbers, (otherwiſe called parts or Fractions) but firſt of all, *Reduction* of *Fractions* or broken numbers in ſeverall kinds muſt bee known, which being the *Baſis* of the whole buſineſſe of *Fractions* ought to bee the more diligently obſerved, and is explained in the following rules.

To finde the greateſt cõmon meaſure unto any two numbers.

II. *Two numbers being given, their greateſt common meaſure (that is, the greateſt number which will meaſure or divide either of the numbers given without leaving any remainder) may be found in this manner,* viz. *Divide the greater number by the leſſe, then divide the laſt Diviſor by the remainder, (if there be any) and ſo continue dividing the laſt Diviſors by the remainders untill there bee no remainder,*

mainder, (neglecting the quotients) ſo is the laſt Diviſor the greateſt common meaſure unto the numbers given.

Thus, if the greateſt *common meaſure* unto the numbers 91 and 117 bee ſought, divide the greater number 117 by 91, ſo the remainder is 26, by which dividing 91, the remainder is 13, by which dividing 26, the remainder is 0; ſo is 13 the greateſt *common meaſure* unto the numbers 117 and 91, as is manifeſt in dividing each of them by 13; for 13 is found in 91 preciſely 7 times, and in 117 preciſely 9 times.

```
91) 117 (1
    91
    ---
    26) 91 (3
        78
        --
        13) 26 (2
            26
            --
            0
```

III. *A ſingle Fraction may be reduced into the leaſt termes, in dividing the Numerator and denominator by their greateſt common meaſure, for the quotients will bee the Numerator and Denominator of a fraction equall to the former, and in the leaſt termes.* To reduce a Fraction into the leaſt termes, viz. 1. By a generall Rule.

So if the *Fraction* $\frac{91}{117}$ be given to be reduced into the *leaſt termes*, finde the greateſt

teſt common meaſure unto 91 and 117 by the laſt *Rule*, which will be found 13, then dividing 91 by 13, the quotient will be 7 for a new Numerator, alſo dividing 117 by 13, the quotient will bee 9 for a new Denominator, ſo is the *Fraction* $\frac{91}{117}$ reduced into the *leaſt termes*, viz. into the *Fraction* $\frac{7}{9}$: But here you are to obſerve, that if the greateſt *common meaſure* unto the Numerator and Denominator be 1, ſuch *Fraction* is in its *leaſt termes* already, ſo the *Fraction* $\frac{12}{131}$ cannot be reduced into lower termes, becauſe the greateſt *common meaſure* will bee found 1, (by the 2d *Rule* of this Chapter) the like may happen of infinite others; And although the laſt be a generall *Rule* for the Reduction of *Fractions* into their *leaſt termes*, yet there are other practicall *Rules*, which in ſome caſes will be more ready, (eſpecially unto beginners) viz.

2 By particular Rules.

IV. *When the Numerator and Denominator are even numbers, they may be meaſured or divided by* 2. *Therefore in ſuch caſe you may* (*as is taught in the* 21 *Rule of the* 5th. *Chapter*) *take the halfe of the Numerator for a new Numerator, Alſo the halfe of the Denominator for a new Denominator.* So if $\frac{16}{64}$ bee given,

draw

draw at length the line which ſeparates the Numerator from the Denominator, and croſſe the ſame with a down right ſtroke neere the *Fraction*, as you ſee in the *Margent*, then take the halfe of 16, which is 8, for a new Numerator, alſo the halfe of 64, which is 32, for a new Denominator; Againe the halfe of 8 is 4, for a new Numerator, alſo the halfe of 32, is 16, for a new Denominator, and proceeding in like manner, there will bee found $\frac{1}{4}$ equivalent unto $\frac{16}{64}$.

16	8	4	2	1
64	32	16	8	4

V. *When the Numerator and Denominator doe each of them end with* 5, *or one of them ending with* 5, *and the other with a cypher, they may be both meaſured or divided by* 5. So $\frac{225}{475}$ will bee reduced into $\frac{9}{19}$; and $\frac{50}{425}$ into $\frac{2}{17}$, as by the operation in the *Margent* is manifeſt.

225	45	9
475	95	19

50	10	2
425	85	17

VI. *Whenſoever you can eſpy any other number, which will exactly meaſure the Numerator and Denominator,* (*although it be not the greateſt common meaſure*) *you may*

may divide the Numerator and Denominator by ſuch number as before: So $\frac{28}{84}$ may be firſt reduced into $\frac{7}{21}$ by 4, and $\frac{7}{21}$ may be reduced into $\frac{1}{3}$ by 7, as by the operation is manifeſt.

28 | 7 | 1
84 | 21 | 3

VII. *When the Numerator and denominator doe each of them end with a cypher or cyphers, cut off equall cyphers in both, ſo will the fraction be reduced into leſſer termes:* So $\frac{400}{500}$ is reduced into $\frac{4}{5}$, and $\frac{700}{9000}$ into $\frac{7}{90}$.

4 | 00
5 | 00

7 | 00
90 | 00

To find the value of a ſingle fraction in the known parts of the Integer.

VIII. *The value of a ſingle Fraction in the known parts of the Integer, may be found in this manner, viz. Multiply the Numerator of the Fraction propounded, by the number of known parts of the next inferiour denomination which are equall to the Integer, and divide that product by the denominator, ſo is the quotient the value of the Fraction in that inferiour denomination, and if there happen to bee any fraction in the quotient, you may finde the*

value

value thereof in the next inferiour denomination, by the ſame Rule, and ſo proceed till you come to the leaſt known parts.

So the *value* of $\frac{4}{16}$ of a pound *ſterling* will be found 11.*s.* 3 *d.* viz. multiplying the Numerator 9, by 20 (the number of ſhillings which are equall to a pound *ſterling*) the product is 180, which being divided by the denominator 16, the Quotient is 11 $\frac{4}{16}$ ſhillings. In like manner, the value of $\frac{4}{16}$ of a ſhilling will be found 3 pence, for multiplying the Numerator 4 by 12, (the number of pence in a ſhilling) the product is 48, which being divided by the denominator 16, the Quotient is 3 pence. Alſo the *value* of $\frac{7}{12}$ of a pound *ſterling* will bee found 10. *s.* 9 $\frac{1}{12}$ *d.* And $\frac{11}{96}$ of a pound *Troy* will be found equivalent unto 3 ounces 17 penny waight and 12 graines.

20
9
16) 180 (11 $\frac{4}{16}$
16
20
16
4
12
16) 48 (3
48
0

IX. *A mixt number may bee reduced into an*

To reduce a mixt number into an improper fraction.

an improper fraction equivalent unto the mixt number, in this manner, viz. Multiply the Integrall part of the mixt number, by the denominator of the Fraction annexed to the Integers, and unto the Product adde the Numerator of the ſaid Fraction, ſo is the ſumme the Numerator of an improper fraction, whoſe denominator is the ſame with that of the ſaid fraction annexed.

So $4\frac{11}{12}$ will be reduced into the *improper fraction* $\frac{59}{12}$, for 4 being multiplyed by 12, the Product is 48. unto which adding the Numerator 11, the ſumme is 59 for a new Numerator, which being placed over the Denominator 12, gives the *improper fraction* $\frac{59}{12}$, which is equivalent unto $4\frac{11}{12}$, (as will appeare by the 12th. *Rule* of this Chapter.)

To reduce a whole number into an improper fraction.

X. *A whole number is reduced into an improper fraction, by placing the whole Number given, as a Numerator, and* 1 *as a denominator.*

So 14 *Integers* will be reduced into the *improper fraction* $\frac{14}{1}$ and one *Integer* into the *improper fraction* $\frac{1}{1}$.

XI. *A whole number is reduced into an improper fraction which ſhall have any denominator aſſigned, in multiplying the whole*

whole number given, by the denominator aſſigned, and placing the Product as a Numerator, over the ſaid denominator.

So if 13 be given to be reduced, into an *improper fraction* whoſe denominator ſhall be 4, multiply 13 by 4. ſo is the Product 52, which being placed over 4, gives the *improper fraction* $\frac{52}{4}$, equivalent unto 13, (as will appear by the next *Rule*) in like manner 13 may be reduced into $\frac{91}{7}$.

XII. *An improper fraction may bee reduced into its equivalent whole number or mixt number, in this manner, viz. divide the Numerator by the denominator, ſo is the quotient the whole number or mixt number ſought:* So the *improper fraction* $\frac{59}{12}$ will bee reduced into the *mixt number* $4\frac{11}{12}$, for if 59 bee divided by 12, the quotient is $4\frac{11}{12}$; Alſo the *improper fraction* $\frac{52}{4}$ will bee reduced into the whole number 13.

To reduce an improper fraction into its equivalēt whole or mixt number.

XIII. *Fractions having unequall denominators, may be reduced into fractions of the ſame value which ſhall have equall denominators, by this Rule and the next following, viz. when two fractions having unequall denominators are propounded, to be reduced into two other fractions of the ſame value which ſhall have a common deno-*

To reduce fractions to a common denominator; viz. 1. When two fractions are propounded.

denominator, multiply the Numerator of the first fraction, (that is, either of them) by the denominator of the second, so is the product a new Numerator (correspondent unto the Numerator of that first fraction,) Also multiply the Numerator of the second fraction by the Denominator of the first, so is the Product a new Numerator (correspondent unto the Numerator of the second fraction) lastly, multiply the Denominators one by the other, so is the Product a common denominator to both the new Numerators.

Thus if the fractions $\frac{2}{3}$ and $\frac{4}{5}$ bee propounded, multiply 2 by 5, so is the product 10 for a new Numerator correspondent unto 2: also multiply 4 by 3, so is the product 12, which is a new Numerator coresponden unto 4: lastly multiply 3 by 5, so is the product 15, which shall be a *common denominator* unto the new Numerators; so the *Fractions* $\frac{10}{15}$ and $\frac{12}{15}$ are found, which have *equall denominators* and each of these new *Fractions* is equall unto its correspondent *Fraction* first

$$\frac{2}{3} \times \frac{4}{5} \qquad \frac{10}{15} \quad \frac{12}{15}$$

given

given, viz. $\frac{10}{15}$ is equall unto $\frac{2}{3}$, and $\frac{12}{15}$ is equall unto $\frac{4}{5}$, (as will be manifeſt by the 3d. *Rule* of this Chapter.)

XIV. *When three or more fractions which have unequall denominators, are given to bee reduced as in the laſt Rule, multiply the Numerator of each fraction and all the denominators excepting its own, continually, ſo are the ſeverall products ariſing from ſuch continuall multiplication, new Numerators; Laſtly multiply all the denominators continually, ſo is the product a common denominator to all the new Numerators.*

2. When 3 or more fractions are propounded. See continuall Multiplication in the laſt Rule of the 4 Chapter.

So if the *fractions* $\frac{3}{8}$, $\frac{2}{5}$, and $\frac{1}{7}$, having unequall denominators, are given to bee reduced into three other *fractions* of the ſame value, which ſhall have *equall denominators*, multiply the Numerator 3, into the denominators 5 and 7 continually, ſo is the product 105; Alſo multiply the Numerator 2, into the denominators 8 and 7, continually, ſo is the Product 112; In like manner multiplying the Numerator 5, into the denominators 8 and 5 continually the product is 200, which 3 products are 3 new Numerators; Laſtly multiply all the denominators 8, 5, and 7 continually, ſo is the Product 280 which is *a common denominator*

minator to all the new Numerators; thus the *fractions* $\frac{105}{280}$, $\frac{112}{280}$, and $\frac{200}{280}$ are found, which have *equall denominators*, and each of these new *fractions* is equall unto its correspondent *fraction* first given, viz. $\frac{105}{280}$ is equall unto $\frac{3}{8}$, $\frac{112}{280}$ is equall unto $\frac{2}{5}$, and $\frac{200}{280}$ is equall unto $\frac{5}{7}$, as will be manifest by the third *Rule* of this Chapter.

$$\begin{array}{ccc} \frac{3}{8} & \frac{2}{5} & \frac{5}{7} \\ \hline \frac{105}{280} & \frac{112}{280} & \frac{200}{280} \end{array}$$

To reduce a compound fraction to a single fraction. See continuall multiplication in the last Rule of the 4 Chapter.

XV. *A compound fraction (otherwise called a fraction of a fraction) may be reduced into a single fraction in this manner, viz. Multiply all the Numerators continually, so is the Product a new Numerator, also multiply all the denominators continually, so is the Product a new denominator.*

Thus if the *compound fraction* $\frac{2}{3}$ of $\frac{1}{4}$, be given to bee reduced into a *single fraction*, multiply the Numerators 2 and 3, one by the other, so is the product 6 for a new Numerator. Also multiplying the Denominators 3 and 4 one by the other, the product is 12 for a new denominator, so is $\frac{6}{12}$ (or $\frac{1}{2}$) the *single fraction* sought, being equivalent

$\frac{2}{3}$ of $\frac{1}{4}$

$\frac{6}{12}$ | $\frac{1}{2}$

unto

unto $\frac{3}{4}$ of $\frac{1}{4}$ the *compound Fraction*, given to bee reduced: In like manner the *compound Fraction* $\frac{1}{4}$ of $\frac{1}{4}$ of $\frac{4}{5}$, will be reduced into the *ſingle Fraction* $\frac{4}{80}$ (or $\frac{1}{20}$).

Here you may obſerve, that when any terme in a queſtion belonging to any of the ſubſequent Chapters, is a *compound Fraction*, it is firſt of all to be reduced into a *ſingle Fraction* by the laſt mentioned *Rule*.

To finde whole numbers which ſhall have the ſame reaſon as any fractions or mixt numbers given.

XVI. *Two or more Fractions being given, there may bee whole numbers found, which ſhall have the ſame Reaſon or Proportion as the Fractions given*, viz. *When the Fractions given have unequall denominators, reduce them into equivalent Fractions which ſhall have a common denominator, (by the 13th. or 14th. Rule of this Chapter) then rejecting the common denominator, the Numerators ſhall have the ſame Reaſon or Proportion as the Fractions firſt given.*

So $\frac{1}{5}$ and $\frac{1}{8}$ being given, will firſt of all be reduced into their equivalent Fractions $\frac{24}{40}$ and $\frac{25}{40}$, Then rejecting the common denominator 40, the Numerators 24 and 25 will have the ſame *Reaſon* with $\frac{1}{5}$ and $\frac{1}{8}$, *viz.* As $\frac{1}{5}$ is to $\frac{1}{8}$, ſo is 24 to 25: Alſo if the fractions $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ were gi-

ven, there will bee found 8, 16, and 32, which are in the ſame proportion one to the other as the fractions given: In like manner if mixt numbers bee given, there may bee whole numbers found which ſhall have the ſame *Reaſon* or *Proportion* as the mixt numbers, ſo $5\frac{2}{3}$ and $3\frac{1}{8}$ being given, will bee firſt reduced into the improper fractions $\frac{17}{3}$ and $\frac{25}{8}$ (by the 9th. Rule of this Chapter:) Alſo the ſaid $\frac{17}{3}$ and $\frac{25}{8}$ will bee reduced into $\frac{136}{24}$ and $\frac{87}{24}$, then rejecting the common denominator 24, the Numerators 136 and 87 will have the ſame *Reaſon* as $5\frac{2}{3}$ and $3\frac{1}{8}$, viz. As 136 is to 87, ſo is $5\frac{2}{3}$ to $3\frac{1}{8}$: Alſo $16\frac{1}{2}$ and 18 being given, there will bee found 33 and 36, which reduced into their loweſt termes (by the 2d Rule of this Chapter) will bee 11 and 12 which have the ſame *Reaſon* as $16\frac{1}{2}$ and 18.

CHAP.

Chap. VIII.

Of Addition of Fractions and mixt numbers.

I. *When the termes given to bee added are ſingle Fractions and have a common denominator; adde all the Numerators together, ſo is the ſumme the Numerator of a Fraction, whoſe denominator is the ſame with the common denominator, which new Fraction is the ſumme of the Fractions given to be added.*

To adde ſingle fractions. viz. 1. When they have equall denominators.

So $\frac{1}{9}$ and $\frac{3}{9}$ being given to bee added, their *ſumme* will bee found $\frac{4}{9}$; *viz.* the *ſumme* of the Numerators 3 and 1, is 4, which being placed over the common denominator 9, gives $\frac{4}{9}$: In like manner the *ſumme* of theſe *Fractions* $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ and $\frac{1}{5}$ will bee found $\frac{12}{5}$, which (by the 13th. *Rule* of the 7th. Chapter) will be found equivalent unto $2\frac{2}{5}$, ſo that $2\frac{2}{5}$ is the *ſumme* of the *Fractions* given to be added.

II. *When the Fractions given to bee added have not a common denominat, or they are firſt to bee reduced into Fractions of the ſame value which ſhall have a common*

2. When they have unequal denominators.

denominator (by the 13th. *or* 14th. *Rule of the* 7th. *Chapter) and then they may bee added by the first Rule of this Chapter.*

So if $\frac{2}{3}$ and $\frac{3}{5}$ were given to bee added, their *summe* will bee found $1\frac{4}{15}$; for (by the 13th. Rule of the 7th. Chapter) $\frac{2}{3}$ and $\frac{3}{5}$ will be reduced into their equivalent fractions $\frac{10}{15}$ and $\frac{9}{15}$, which having equall denominators may be added according to the last Rule, and so the *summe* will bee found $1\frac{4}{15}$. In like manner the *summe* of these *Fractions* $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$ will bee found $1\frac{5}{6}$.

$$\begin{array}{ccc} \frac{2}{3} & \times & \frac{3}{5} \\ \hline 10 & & \\ 9 & & \\ \hline \frac{19}{15} & & \end{array}$$

that is $1\frac{4}{15}$

The Addition of compound fractions.

III. *When any of the Fractions given to bee added is a compound Fraction, such compound Fraction is first of all to be reduced into a single Fraction by the* 15th. *Rule of the* 7th. *Chapter, and then you may proceed as before.*

So $\frac{1}{5}$, and $\frac{2}{3}$ of $\frac{1}{4}$ being given to bee added, their *summe* will bee found $\frac{21}{30}$ Here you may observe, that the *fractions* given to bee added in all the former cases, are supposed to bee fractions of Integers which have one and the same *particular denomi-*

denomination, viz. if one of the *fractions* given to bee added, bee a *fraction* of a pound *ſterling*: all the reſt are alſo to be fractions of a pound *ſterling*, and the like is to bee underſtood of other denominations.

See what is meant by denominations in the 1 Rule of the 6 Chap.

IV. *When fractions of Integers of different denominations are given to be added, they are firſt of all to be reduced into fractions of Integers which ſhall have one and the ſame particular denomination (by the 15th. Rule of the 7th. Chapter) and then they may bee added by the 1t. or 2d. Rule of this Chapter.*

To adde fractions of Integers which have different denominations

So if $\frac{2}{9}$ of a pound *ſterling*, $\frac{1}{5}$ of a ſhilling, and $\frac{1}{8}$ of a penny were given to be added, reduce the two latter into *fractions* of a pound *ſterling* by the 15th. *Rule* of the 7th. Chapter *viz.* $\frac{1}{5}$ of a ſhilling is $\frac{1}{5}$ of $\frac{1}{20}$ of a pound *ſterling*, which *compound fraction* being reduced into a *ſingle fraction*, gives $\frac{1}{100}$ *li.* Likewiſe $\frac{1}{8}$ of a penny, is $\frac{1}{8}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound *ſterling*, which *compound fraction* being reduced, gives $\frac{1}{384}$ *li.* Laſtly $\frac{2}{9}$ *li.* $\frac{1}{100}$ *li.* and $\frac{1}{384}$ *li.* being added according to the 2d *Rule* of this Chapter, the *ſumme* will bee found $\frac{23339}{28800}$ *li.*

V. *When mixt numbers are given to be added, finde firſt of all the ſumme of the*

To adde mixt numbers.

fractions by the 1°. or 2^d. Rule of this Chapter, then adde the Integer or Integers (if there bee any found) in the ſumme of the fractions, unto the whole numbers and collect the ſumme of them as you were taught by the 10th. and 11th. Rules of the 2^d. Chapter.

So if $3\frac{1}{2}$, $4\frac{1}{3}$, and $16\frac{1}{8}$ were given to be added, their *ſumme* will be found $24\frac{11}{24}$, *viz.* the *ſumme* of the fractions $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{8}$ will bee found (by the 2^d. Rule of this Chapter) to bee $1\frac{11}{24}$, and the *ſumme* of the whole number 3, 4, and 16, is 23, unto which adding 1 (the Integer found in the ſumme of the fractions) the *ſumme* is 24, ſo that $24\frac{11}{24}$ is the *ſumme* of the mixt numbers given to be added.

Chap. IX.

Of Subtraction of Fractions and mixt numbers.

The ſubtraction of ſingle fractions viz. 1. When they have a common denominator.

I. *When the termes given are both ſingle fractions and have a common denominator, ſubtract the leſſer numerator from the greater, and place the remainder over the common denominator, ſo is ſuch new fraction the difference betweene the fractions given.* Thus

Thus the difference betweene the fractions $\frac{2}{11}$ and $\frac{7}{11}$, is $\frac{5}{11}$; Alſo the difference between the fractions $\frac{11}{21}$ and $\frac{17}{21}$, is $\frac{6}{21}$.

II. *When the termes given are both ſingle fractions and have not a common denominator, reduce them into fractions of the ſame value which ſhall have a common denominator (by the 13th. or 14th. Rule of the 7th. Chapter) and then find their difference by the laſt Rule.*

2 When they have unequall denominators.

So the *difference* between the *fractions* $\frac{3}{7}$ and $\frac{7}{8}$, will be found $\frac{1}{56}$, *viz.* reducing the *fractions* given, into their equivalent *fractions* $\frac{24}{56}$ and $\frac{49}{56}$ which have a common denominator, the *difference* ſought will be found $\frac{1}{56}$, by the firſt *Rule* of this Chapter.

III. *When one of the termes given is a whole number or a mixt number, alſo when both of them are mixt numbers, reduce ſuch whole, or mixt numbers into an improper fraction or fractions, by the 9th. or 10th. Rule of the 7th. Chapter, and then the operation will be according to the 1. or 2d. Rule of this Chapter.*

The ſubtraction of mixt numbers. *viz.* 3 By a generall Rule.

So $7\frac{1}{3}$ being given to be ſubtracted from 12, the *remainder* will be found $4\frac{2}{3}$; Alſo $9\frac{1}{2}$ being given to be ſubtracted from $12\frac{1}{5}$;

$12\frac{3}{5}$, the *remainder* will be found $2\frac{7}{10}$; as by the ſubſequent operation is manifeſt.

12 $7\frac{1}{5}$	12 $\frac{1}{5}$ $9\frac{1}{2}$
12 8	61 19
1 5	5 2
60	122
38	95
$22\frac{2}{5}$ that is $4\frac{2}{5}$.	$22\frac{7}{10}$ that is $2\frac{7}{10}$

Although the 3 laſt *Rules* bee ſufficient for all caſes in *ſubtraction* of *fractions*, mixt numbers, or whole and mixt, nevertheleſſe the following *Rules* will bee more expeditious in the ſubtraction of mixt numbers, or whole and mixt, eſpecially when the *Integrall part* conſiſts of many places, as will be manifeſt by the operation, *viz.*

2 By particular Rules viz. 1 A whole number from a mixt number.

IV. *When a whole number is given to bee ſubtracted from a mixt number, ſubtract the ſaid whole number from the whole part of the mixt number (as is taught by the* 3d. *and* 4th. *Rules of the* 3d. *Chapter) and unto the remainder annex the fractionall part of the mixt number given, ſo is the mixt number thus found the remainder or difference ſought.*

As

As if 7 bee given to bee ſubtracted from $24\frac{1}{8}$ the *remainder* will be $17\frac{1}{8}$ as by the operation is manifeſt.

$$\begin{array}{r} 24\ \frac{1}{8} \\ -\ 7 \\ \hline 17\ \frac{1}{8} \end{array}$$

V. *When a fraction is given to bee ſubtracted from an Integer, ſubtract the Numerator from the denominator, and place that which remaines over the Denominator, which new fraction thus found, is the remainder or difference ſought.* 2. A fraction from an Integer.

So $\frac{1}{3}$ being ſubtracted from an *Integer* or 1, the *remainder* is $\frac{2}{3}$: Alſo $\frac{11}{19}$ being ſubtracted from 1, the *remainder* is $\frac{8}{19}$.

VI. *When a fraction is given to be ſubtracted from a whole number greater then 1, ſubtract the ſaid fraction from one of the Integers given (by the laſt Rule) ſo the remaining Fraction being annexed to the number of Integers leſſened by unity or 1, gives the remainder or difference ſought.* 3. A fraction from a whole number greater then 1.

Thus $\frac{1}{7}$ being ſubtracted from 17, the *remainder* is $16\frac{6}{7}$: Alſo $\frac{7}{12}$ being ſubtracted from 39, the *remainder* is $38\frac{5}{12}$.

VII. *When a mixt number is given to be ſubtracted from a whole number, ſubtract firſt of all (by the 5th. Rule of this Chapter) the fractionall part of the mixt number* 4 A mixt number from a whole number.

number, from an Integer borrowed from the whole number given, and ſet down the remaining fraction, then adding the Integer borrowed, unto the Integers of the mixt number, ſubtract the ſaid ſumme from the whole number given, (as is taught in ſubtraction of whole numbers) ſo that which remaines, together with the remaining fraction before found, is the remainder or difference ſought.

So if $9\frac{7}{12}$ be ſubtracted frō 50, the *remainder* is $40\frac{5}{12}$, as by the operation is manifeſt.

50
$9\frac{7}{12}$
$40\frac{5}{12}$

5. A fraction from a mixt number by this and the next Rule.

VIII. *When a fraction is given to bee ſubtracted from a mixt number, and the ſaid fraction is leſſe then the fractionall part of the mixt number, ſubtract the leſſer fraction from the greater by the 1ſt. or 2d. Rule of this Chapter, ſo the remaining fraction being annexed to the whole part of the mixt number, gives the remainder or difference ſought.*

So $\frac{1}{9}$ being ſubtracted from $12\frac{7}{8}$, the *remainder* is $12\frac{55}{72}$, as

$12\frac{7}{8}$
$0\frac{1}{9}$
$12\frac{55}{72}$

by

by the operation is manifeſt.

IX. *When a fraction is given to bee ſubtracted from a mixt number, and the ſaid fraction is greater then the fractionall part of the mixt number, ſubtract the ſaid greater fraction from an Integer borrowed from the mixt number, (by the 5th. Rule of this Chapter) and adde the remaining fraction unto the fractionall part of the mixt number (by the 1t. or 2d. Rule of the 8th. Chapter) ſo the fraction found by that addition, being annexed to the whole part of the mixt number leſſened by an Integer, or 1, gives the remainder or difference ſought.*

Thus $\frac{4}{9}$ being ſubtracted from $13\frac{1}{8}$, the *remainder* is $12\frac{19}{72}$, *viz.* ſubtracting $\frac{4}{9}$ from 1, the remainder is $\frac{5}{9}$ which added to $\frac{1}{8}$ gives $\frac{17}{72}$, which being annexed to 12 (the number of *Integers*, in the mixt number leſſened by 1 or unity) gives $12\frac{19}{72}$ the *remainder* ſought.

$$\begin{array}{r} 13\frac{1}{8} \\ 0\frac{4}{9} \\ \hline 12\frac{19}{72} \end{array}$$

X. *When a mixt number is given to be ſubtracted from a mixt number, and the fractionall part of the mixt number to bee ſubtracted, is leſſe then the fractionall part of the mixt number from which you are to ſub-*

6. A mixt number from a mixt number by this and the next Rule.

ſubtract, ſubtract the ſaid leſſer fraction from the greater, (by the 1t. or 2d. Rule of this Chapter) and ſet down the remaining fraction: alſo ſubtract the Integers of the leſſer mixt number from the Integers of the greater (as in Subtraction of whole numbers) ſo is the mixt number thus found, the remainder or difference ſought.

So if $17\frac{1}{8}$ bee given to be ſubtracted from $20\frac{5}{7}$, the *remainder* will bee found $3\frac{12}{56}$; *viz.*

$$\begin{array}{r} 20\frac{5}{7} \\ 17\frac{1}{8} \\ \hline 3\frac{12}{56} \end{array}$$

ſubtracting $\frac{1}{8}$ from $\frac{5}{7}$, the *remainder* is $\frac{12}{56}$, Alſo ſubtracting 17 from 20 the remainder is 3.

XI. *When a mixt number is given to bee ſubtracted from a mixt number, and the fractionall part of the mixt number to be ſubtracted, is greater then the fractionall part of the mixt number from which you are to ſubtract, ſubtract the ſaid greater fraction from an Integer borrowed from the greater mixt number (by the 5th. Rule of this Chapter) and adde the remaining fraction unto the fractionall part of the leſſer mixt number (by the 1t. or 2d. Rule of the 8th. Chapter) ſo is the ſumme to be reſerved as the fractionall part of the remainder*

remainder ſought; then adde the Integer borrowed, unto the Integers of the leſſer mixt number, and ſubtract the ſumme from the Integers of the greater mixt number, (as in Subtraction of whole numbers) ſo that which remaines, together with the fraction before reſerved, is the remainder or difference ſought.

Thus if $20\frac{7}{8}$ be given to be ſubtracted from $35\frac{1}{5}$, the *remainder* will bee found $14\frac{22}{40}$; *viz.* ſubtracting $\frac{7}{8}$ from $35\frac{1}{5}$

an *Integer* or 1, $20\frac{7}{8}$

the *remainder* is $14\frac{22}{40}$

$\frac{1}{8}$ which added to $\frac{1}{5}$ gives $\frac{22}{40}$, then adding the *Integer* borrowed unto 20, it will bee 21, which ſubtracted from 35, the *remainder* is 14, ſo that the *remainder* or *difference* ſought is $14\frac{22}{40}$.

To diſcerne the greater of 2 fractions.

When you cannot cleerly diſcerne which is the greater of two *fractions*, having unequall denominators, reduce them into *fractions* of the ſame value which ſhall have a common denominator, by the 13th. *Rule* of the 7th. Chapter, and then it will be apparent.

CHAP.

Chap. X.

Of Multiplication of Fractions and mixt numbers.

To multiply single fractions.

I. *When the termes given to be multiplyed are both single fractions, multiply the numerators one by the other, so is the product a new numerator. Also multiply the denominators one by the other, so is the product a new denominator, which new fraction is the product sought:*

So $\frac{7}{12}$ and $\frac{5}{8}$ being given to be multiplyed, the *product* will be found $\frac{35}{96}$: Also $\frac{3}{5}$ and $\frac{1}{7}$ being multiplied one by the other, the *product* will will bee found $\frac{3}{35}$. Here you may observe, that in multiplication of *Fractions*, the *Product* is always lesse then either of the termes given, for in *multiplication*, as unity or 1 is to either of the termes given, so is the other terme to the *product*.

To multiply mixt numbers.

II. *When one of the termes given is a whole number or a mixt number; Also when both of them are mixt numbers, reduce such whole number or mixt number or numbers into an improper fraction or fractions*

fractions by the 9th. or 10th Rule of the 7th Chapter, and then the operation will be the same as in the last Rule.

So $8\frac{1}{3}$ being given to be multiplyed by 5, the *Product* will be found $43\frac{1}{3}$; *viz.* $8\frac{1}{3}$ being reduced into an improper *fraction* will bee $\frac{26}{3}$: Also 5 will bee $\frac{5}{1}$, then multiplying 26 by 5, the *Product* is 130 for a new numerator: Also multiplying 3 by 1, the *Product* is 3 for a new denominator, which new *Fraction* $\frac{130}{3}$ being reduced (according to the 12th. *Rule* of the 7th. Chapter) will bee $43\frac{1}{3}$ the *Product* sought. In like manner $7\frac{1}{2}$ being multiplyed by $5\frac{1}{3}$, the *Product* will bee found 42. Here observe, that when either of the termes given is a *compound Fraction* it is first of all to bee reduced into a *single Fraction*, and then the operation is as before.

Other *Rules* might be prescribed for the multiplication of mixt numbers, but because the operation by such *Rules* would be little or nothing briefer then the operation by the last *Rule*, it would be superfluous to expresse them.

CHAP.

Chap. XI.

Of Division of Fractions and mixt numbers.

The division of single Fractions.

I. *When the termes given are both single fractions, multiply the denominator of the Divisor by the numerator of the Dividend, so is the product a new numerator: Also multiply the numerator of the Divisor by the denominator of the Dividend, so is the product a new denominator, which new fraction is the quotient sought.*

So if $\frac{4}{5}$ bee given to be divided by $\frac{3}{5}$, the *quotient* will bee found $\frac{20}{27}$, *viz.* multiplying 5 by 4 the product is 20 for a new numerator, also multiplying 3 by 9, the product is 27 for a new denominator, so is $\frac{20}{27}$ the *quotient* sought; In like manner if $\frac{2}{3}$ bee given to bee divided by $\frac{2}{7}$, the

Divisor	Dividend
3	4
5	9
	$\frac{20}{27}$ quotient

the quotient will be found $2\frac{3}{16}$, as by the operation in the *Margent* is manifest. Here you may observe that in *Division* by *Fractions*, the *quotient* is alwayes greater then either of the *Fractions* given; for in *Division*, As the *Divisor* is to unity or 1, so is the *Dividend* to the *quotient*.

$$\begin{array}{cc} 2 & 5 \\ \hline 7 & 8 \\ \hline \end{array}$$

$\frac{35}{16}$ that is $2\frac{3}{16}$.

II. *When one of the Termes given is a whole number or a mixt number; Also when both are mixt numbers, Reduce such whole number or mixt number or numbers into an improper Fraction or Fractions, by the 9th. or 10th. Rule of the 7th. Chapter, and then the operation will be the same as in the last rule.* The division of mixt numbers.

So if 42 be divided by $7\frac{1}{2}$, the *quotient* will be found $5\frac{3}{5}$, as by the operation in the *Margent* is manifest.

$$\begin{array}{cc} 7\frac{1}{2} & 42 \\ \hline 15 & 42 \\ \hline 2 & 1 \end{array}$$

$\frac{84}{15}$ that is $5\frac{3}{5}$

In like manner if $6\frac{1}{2}$ be divided by $3\frac{2}{5}$, the *quotient* will be found $1\frac{35}{34}$. Also if $5\frac{1}{3}$ be divided by $12\frac{1}{2}$ the quotient will bee found $\frac{32}{75}$. Here observe, that when either of the Termes given is a *compound Fraction*, it is to be reduced into a *single Fraction*, and then the operation will be as before.

Chap. XII.

Of the reduction of vulgar Fractions into Decimalls.

1. That which hath been performed by *vulgar Fractions* in the 8th, 9th, 10th, and 11th. Chapters, may be also effected with farre more conveniency and facility by *decimall Fractions*; (as will be manifest in the following Chapters) whose excellent use in *Arithmetique* in generall, but especially in the Doctrine of *plaine Triangles*, and the practicall part of *Geometry*, is well known to such who are exercised in *Calculations*: Now to the end that questions which are totally or in part composed of *vulgar Fractions*, may be resolved by *decimalls*, the way of reducing *vulgar Fractions* to *decimalls* is first to be known, which this chapter principally aimeth at. The invention of *decimall Arithmetique* writes not many yeares; and since the first invention thereof, time and practise hath added much perfection thereunto: divers challenge the first invention of it, but truely I know not; The truth is, there-

see the definitions of Decimalls in Chap. 1.

no man much verst in *Calculations*, but must needs upon some occasion or other fall upon it: for my part I confesse the first light I received of that way, was out of *Ramus* in the Extraction of the square and cube roots; for by annexing Cyphers unto the square and cube numbers, the broken parts of the roots are converted into *Decimals*, *ipso facto*; as you shall hereafter be taught by the 19th. *Rule* of the 17th. Chapter, and by the 22th. *Rule* of the 18. chapter of this present booke.

Ram. Gem. l. 12. Elem. 8. & l. 24. Elem. 6.

II. *A single Fraction which is no Decimall, may be reduced to a Decimall of the same value, or infinitely neere by Division; For if unto the Numerator of the Fraction propounded, Cyphers at pleasure be annexed, and the whole be divided by the Denominator, the quotient is the decimall required.*

Of the Reduction of vulgar Fractions to Decimalls. viz. 1 Single Fractions.

So $\frac{5}{8}$ being propounded to be reduced to a *decimall* will be changed into .625, that is $\frac{625}{1000}$, for annexing Cyphers unto the Numerator 5. it will be 5000. &c which being divided by the *Denominator* 8, the quotient will be 625, before which, prefixing a point, it will be .625. (that is $\frac{625}{1000}$) the *decimall* sought: Also $\frac{1}{2}$ will be reduced into the *decimall* .5, (or $\frac{5}{10}$) and $\frac{1}{5}$ in-

to .2857,&c. or $\frac{2857}{10000}$ almoſt, for $\frac{2}{7}$ cannot be converted into a *decimal* exactly equall unto it, and the like will happen in the *Reduction* of moſt vulgar *Fractions* to *decimals*, but by the continuall annexing of Cyphers unto the Numerator as before, you may approch infinitely neare. Here you are to obſerve that in reducing a vulgar *fraction* to a *decimal*, it ſometimes falls out, that the firſt place, or more of the foremoſt places of the *decimal* found, will be cypher or cyphers, which may be diſcovered by the next *Rule*, *viz.*

III. *If in the Reduction of a Fraction to a decimal according to the laſt rule, the place of units in the Diviſor at the firſt demand, extend unto the firſt of the cyphers annexed as before, the firſt figure in the quotient will be tenths*, (viz. *the firſt place of the decimal ſought*;) *but if it extend unto the* 2^d. *cypher, the firſt figure in the quotient will be hundreds*, (viz. *the ſecond place of the decimall ſought*) *and in ſuch case one cypher is to be prefixed*; *if unto the third cypher, two cyphers are to be prefixed*, &c.

So $\frac{12}{20}$ will bee reduced into the *decimal* .95; Alſo $\frac{1}{80}$ will bee converted into the *decimal* .0375; Likewiſe $\frac{1}{240}$ will be reduced

reduced into the *decimal* ,00416, &c.

IV. *When a compound Fraction is given to bee reduced to a Decimall, reduce first of all such Compound Fraction into a single Fraction, by the 15th. Rule of the 7th. Chapter, and afterwards such single Fraction into a decimal according to the second and third rules of this Chapter.* 3. Compound Fractions.

So $\frac{11}{24}$ of $\frac{1}{20}$ of $\frac{13}{12}$ (which may represent 13 graines *Troy* waight) being propounded to be reduced to a *Decimal*, will be changed into ,00225, &c. For first of all the said compound Fraction will bee reduced into the single Fraction $\frac{11}{5760}$ and afterwards the said single Fraction into the *decimal*, ,00225, &c.

In like manner *Astronomicall* or *Sexagenary Fractions* may bee reduced into *Decimals*, for since a *Degree* is usually divided into sixtie *Minutes* or *Primes*: 1 *Prime* or *Minute* into sixtie *Seconds*: 1 *Second* into sixtie *Thirds*: 1 *Third* into 60 *Fourths*, &c. and consequently a *Degree* is equall to sixtie *Minutes* or *Primes*, or 3600 *Seconds*, or 216000 *Thirds*, or 12960000 *Fourths*, &c. Therefore 7 *Minutes* or *Primes*, are $\frac{7}{60}$ *Degree*, which (by the second *Rule* of this Chap.)

may be reduced into the *Decimal*, .1166, &c. Also 29 *Thirds* are $\frac{29}{216000}$ *Degree*, which will be reduced into the *Decimal*, ·000134, &c. Moreover, 58′: 33″: 14‴: 12⁗ that is, 58 *Primes*, 33 *Seconds*, 14 *Thirds*, and 12 *Fourths* may be reduced to a *decimal* in this manner, *viz.* Reduce them all into *Fourths*, (according to the third *Rule* of the sixth chapter) so will you finde 12647652 *Fourths*, or $\frac{12647652}{12960000}$ *degree*, which according to the 2 *Rule* of this chap.) will be reduced into the *decimal*, .975899, &c.

V. *Upon the foresaid ground is framed the ensuing* Table, *by helpe whereof the* Fractions *or* knowne parts *of* Money, Waight, Measure, *&c. are reduced to* Decimals, *to the end they may bee made more ape for operation, and such which have much practice in* Astronomicall Calculations *may make* Tables *for the Reduction of* Sexagenary Fractions *into* Decimals, & contra.

Moreover you may observe, that although the *decimals* in most of the *Tables* hereafter explained, consist of 7 or 8 Figures, yet in ordinary practise, you shall, for the most part have occasion to use onely the first 6, and sometimes fewer.

The

The TABLE of REDUCTION.

English Coine.	
Sh. 19	95
18	9
17	85
16	8
15	75
14	7
13	65
12	6
11	55
10	5
9	45
8	4
7	35
6	3
5	25
4	2
3	15
2	1
1	05

D. 11	04583333
10	04166667
9	0375
8	03333333
7	02916667
6	025
5	02083333
4	01666667
3	0125
2	00833333
1	00416667
F. 3	003125
2	002083333
1	001041667

Troy Waight.

O. 11	91666667
10	83333333
9	75

8	66666667		
7	58333333		
6	5	Gr. 23	00399305
5	41666667	22	00381944
4	33333333	21	00364583
3	25	20	00347222
2	16666667	19	00329861
1	08333333	18	003125
		17	00295139
P. 19	079166667	16	00277778
18	075	15	00260417
17	07083333	14	00243056
16	06666667	13	00225694
15	0625	12	00208333
14	05833333	11	00190972
13	05416667	10	00173611
12	05	9	00156250
11	04583333	8	00138889
10	04166667	7	00121528
9	0375	6	00104166
8	03333333	5	00086805
7	02916667	4	00069444
6	025	3	00052083
5	02083333	2	00034722
4	01666667	1	00017361
3	0125		
2	00833333		
1	00416667		

Averdupois great waight.	
3. qu.	75
2. qu.	5
1. qu.	25
lb. 27	24107142
26	23214285
25	22321428
24	21428571
23	20535714
22	19642857
21	1875
20	17857143
19	16964286
18	16071428
17	15178571
16	14285714
15	13392857
14	125
13	11607143
12	10714286
11	09821428
10	08928571
9	08037714
8	07142857
7	0625
6	05357143
5	04464286
4	03571428
3	02678571
2	01785714
1	00892857
Ou. 15	00837053
14	00781125
13	00725446
12	00669643
11	00613839
10	00558035
9	00502232
8	00446429
7	00390625
6	00334821
5	00279018
4	00223214
3	00167411
2	00111607
1	00055804
3. qu.	00041853
halfe	00027902
1. qu.	00013951

Averdupois

Auerdupois little waight.

Oun. 15	9375
14	875
13	8125
12	75
11	6875
10	625
9	5625
8	5
7	4375
6	375
5	3125
4	25
3	1875
2	125
1	0625
Dr. 15	05859375
14	0546875
13	05078125
12	046875
11	04296875
10	0390625
9	03515625
8	03125
7	02734375
6	0234375
5	01953125
4	015625
3	01171875
2	0078125
1	00390625
3. qu.	00292969
halfe	00195312
1. qu.	00097656

Liquid Measures.

Pi. 7	875
6	75
5	625
4	5
3	375
2	25
1	125
1/2	09375
1/2	0625
1/4	03125

Drie

Drie Measures.

Bu. 7	875
6	75
5	625
4	5
3	375
2	25
1	125
Pec. 3	09375
2	0625
1	03125
½	0234375
¼	015625
⅛	0078125
Pi. 3	0058594
2	0039063
1	0019531

Long Measures, the integers being yards and els.

qu. 3	75
2	5
1	25
nail. 3	1875
2	125
1	0625
39 m.	046875
halfe	03125
1 qu.	015625

Time.

mo. 11	916667
10	833338
9	75
8	666667
7	583333
6	5
5	416667
4	333338
3	250
2	166667
1	083338
dai. 30	082193
29	079454
28	076714
27	073973
26	071233
25	068495

24	065755
23	063016
22	060274
21	057536
20	054795
19	052055
18	049316
17	046577
16	043837
15	041097
14	038357
13	035617
12	032877
11	030137
10	027397
9	024657
8	021918
7	019178
6	016438
5	013698
4	010959
3	0082192
2	0054795
1	0027397

Dozens.

De. 11	9166667
10	8333333
9	75
8	6666667
7	5833333
6	5
5	4166667
4	3333333
3	25
2	1666667
1	0833333
Pa. 11	076388
10	0694444
9	0625
8	0555555
7	0486111
6	0416667
5	0347222
4	0277778
3	0208333
2	0138889
1	0069444

VI. *This Table aforegoing consists of nine severall Tablets, of which the first (intituled English money) contains in the first Columne thereof the particular Fractions* (viz. *the shillings, pence, and farthings*) *of a pound Sterling; and in the other Columne the decimalls, unto which they may be respectively reduced*: So in the same Tablet 65 is the *decimall*, answerable to 13, s. 02083333 to 5, d. and 003125 to 3, f. The Tablet 1. Of English money.

VII. *The next Tablet* (*intituled Troy waight*) *contains in the first Columne thereof the particular Fractions* (viz. *the Ounces, Penny waights, and graines*) *of a pound Troy, and in the other their respective decimalls*: So 66666666 is the correspondent *decimall* of 8 ounces, 05833333 of fourteen penny waight, and 00208333 of 12 graines. 2. Of Troy waight.

VIII. *The third Table* (*intituled Averdupois great waight, contains in the first Columne thereof the Fractions* (viz. *the Quarters, Pounds, Ounces, and quarters of Ounces*) *of a Hundred according to Averdupois waight, and in the other their proper decimalls*: So 5 is the *decimall* of two quarters or half a hundred, 15178571 of 17 pounds; 00334821 of 6 Ounces, and 3. Of Averdupois great waight.

and 000418 53 the *decimall* of 3 quarters of an Ounce.

4. Of Averdupois litle waight.

IX. *The fourth (intituled Averdupois litle waight) sheweth you the Fractions (viz. the Ounces, drams, and quarters of drams) of a pound Averdupois, together with their respective decimalls*: So the *decimall* of three Ounces is 1875, the *decimall* of 9 Drammes is 035156 25, and the *decimall* of one quarter of a Dram is 000976 56.

5. Of liquid Measures.

X. *The fifth (intituled Liquid measures) hath the Fractions (viz. the Pints, and quarters of pints) of a Gallon, and likewise their severall decimalls*: So the *decimall* of five Pints is 625, and the *decimall* of two quarters or halfe of a Pint is 0625.

6. Of Dry Measures.

XI. *The sixth (intituled Dry measures) gives you the Fractions, (viz. the Bushels, Pecks, quarters of Pecks and pintes) of a quarter, together with their peculiar decimalls*: So 375 is the *decimall* of three Bushels, 03125 of one Pecke, 0234375 of $\frac{1}{4}$ of a Pecke, and 0039063 of two Pints.

7. Of Long Measures.

XII. *The seaventh (intituled Yards and Els) offers you the Fractions (viz. the Quarters, Nailes, and quarters of Nails) of Yards or Els, and their respective decimalls*: So 125 is the *decimall* of one quarte

quarter of a Yard or Ell, 125 of two Nailes, and 046875 of three quarters of a Naile.

XIII. *The eighth (intituled Time) presents unto you the Fractions (viz. the Moneths and Dayes) of the Yeare, together with their decimalls:* So 583333 is the *decimall* of seaven moneths, and 043837 of 16 dayes. 8. Of Time.

XIV. *The ninth and last Tablet (intituled Dozens) yields you the Fractions (viz. the dozens and particulars, of a grosse, as also their respective decimalls:* So 25 is the *decimall* of 3 Dozen, and 0486111 of 7 Particulars. 9. Of things accompted by the Dozen.

XV. *When a single Fraction of any of the premised Tablets is propounded to bee reduced to a decimall, finde it in the first Columne of the Tablet, unto which it belongs; this done, just against that Fraction so found, you shall have the decimall required:* So 13 s. being propounded, taking the last premised *Table*, I finde 18 s. in the first Columne of the Tablet of *money*, and just against the same thirteen shillings, I *observe* 65, before which having prefixed a point, and by that means signed it for a *decimall* (according to the twenty fifth Rule of the first Chapter of this The Vse of the same Table for the Reduction 1. Of single Fractions to Decimals.

this Booke) I conclude the same .65 so ordered, to be the correspondent *decimall* of thirteen shillings the fraction propounded: In like manner .0019097 is the *decimall* of 11 Grains in the Tablet of *Troy* waight; and .035714 the *decimall* of 4 lb. in the Tablet of *Averdupois* great *waight*, &c.

XVI *When two or more fractions are propounded, and it is required to finde a decimall equivalent unto the summe of them, finde the decimall of each of the fractions given according to the last Rule; then adding together the decimals so found, that intire summe is the decimall sought:* So 13,s. 5 d. being reduced to a *decimall*, is .670833; for the *decimall* of 13,s. is .65 and the *decimall* of 5, d. .020833, which being added together (by the 2 rule of the 13 Chapter of this Booke) amount to .670833, *viz.* the *decimall* which represents 13, s 5, d. the fraction propounded: In like manner the *decimall* of 5 Ounces, 9 penny waight, and 13 Grains is .45641, and the *decimall* of $\frac{1}{2}$ C. 19, lb. 7 Ounces is .67354, &c.

13, s.

12, s.	.65
5, d.	.020833
	.670833
5, ounces.	.41666
9, p. w.	.0375
13, gr.	.00225
	.45641
½ C.	.5
19. lb	.16964
7. ounc.	.00390
	.67354

And here as you see meere fractions reduced, so likewise may the fractions of mixt numbers be reduced to *decimalls*: for example, these numbers 97, lb. 7, ounces. 13 ¼ dramme. *Item* of 67 Gallons, ¼ pints. *Item* 28 Quarters, 0, Bushell, 2 ½ Pecks, and 3 Pints after reduction are 97, ·4891. 67. 71875, and 28. 078.

97·4375	67·625	28·0625
·0507	·0937	·0156
·0009	67·7187	28·0781
97·4891.		

Again, 22 $\frac{1}{2}$ yards, 3 $\frac{1}{4}$ Nailes; *Item* 17 yeares: 9 moneths, and 22 dayes; *Item* 36 Groſſe, 3 Dozen and 5 particulars, being reduced, are 22 .7031, 17 .8102, 36 .2847.

22. 5		
.1875	17 .75	36 .25
.0156	.06027	.0347
22 .7031	17 .81027	36 .2847

XVII. *When a decimall is propounded to know what Fraction it repreſents, ſearch the ſame decimall in the ſecond Columne of the Tablet, unto which it belongs, when if you finde it expreſly, the number juſt againſt it in the firſt Columne is the fraction you looke for*: So .65 (repreſenting the fraction of a pound *ſterling*) being given, I finde it in the *ſecond Columne* of the Tablet of *Money*, and over againſt it in the firſt *columne* I finde 13, s. which is the fraction repreſented by .65, the *decimall* propounded. In like manner 3 .0024 (repreſenting 3 lb. and .0024 of a pound *Troy*) being propounded, the number repreſented by it, is 3. lb. 0, Qunc. 0, p. 14 graines.

3. Of Decimals to Single Fractions.

XVIII. *When in the ſecond columne of the Tablet, unto which you are directed, ju*

you cannot preciſely finde the decimall propounded, ſearch that, which being leſſe, comes neereſt unto it, and take the number that anſwers unto it in the firſt columne for the greateſt fraction of the number required: then deducting the decimall ſo found out of the decimall given, finde likewiſe the remainder, as another decimall, and take his correſpondent number for the next fraction of the number required; And ſo proceed in that order, till you have diſcovered the intire number repreſented by the decimall propounded.

Example: .6739 being propounded, I demand the fraction of a pound *Sterling* repreſented by it; The decimall in the Tablet of *money*, which being leſſe comes neareſt to .6739 is .65, whoſe correſpondent number in that Tablet is 13, which are the *ſhillings* of the number required; Then ſubtracting (by the 1 *Rule* of the 14 Chapter of this Booke) .65 out of .6739, the remainder is 0239, and the neareſt decimall in the ſame Tablet to 0239 is .0208, whoſe correſpondent number is 5, which are the *pence* of the number required: Laſt of all deducting .0208 out of .0239, the *remainder* is .0031, which gives you in the firſt co-

Again, 22 $\frac{1}{2}$ yards, 3 $\frac{1}{4}$ Nailes; *Item* 17 yeares: 9 moneths, and 22 dayes; *Item* 36 Groſſe, 3 Dozen and 5 particulars, being reduced, are 22 .7031, 17 .8102, 36 .2847.

22. 5		
.1875	17 .75	36 .25
.0156	.06027	.0347
22 .7031	17 .81027	36 .2847

3. Of Decimals to Single Fractions.

XVII. *When a decimall is propounded to know what Fraction it repreſents, ſeeke the ſame decimall in the ſecond Columne of the Tablet, unto which it belongs, when if you finde it expreſly, the number just against it in the firſt Columne is the fraction you looke for*: So .65 (repreſenting the fraction of a pound *ſterling*) being given, I finde it in the *ſecond Columne* of the Tablet of *Money*, and over against it in the firſt *columne* I finde 13, s. which is the fraction repreſented by .65, the *decimall* propounded. In like manner 3 .0024 (repreſenting 3 lb. and .0024 of a pound *Troy*) being propounded, the number repreſented by it, is 3. lb. 0, Qunc. 0, 14 graines.

XVIII. *When in the ſecond columne of the Tablet, unto which you are directed, you*

you cannot preciſely finde the decimall propounded, ſearch that, which being leſſe, comes neereſt unto it, and take the number that anſwers unto it in the firſt columne for the greateſt fraction of the number required: then deducting the decimall ſo found out of the decimall given, finde likewiſe the remainder, as another decimall, and take his correſpondent number for the next fraction of the number required; And ſo proceed in that order, till you have diſcovered the intire number repreſented by the decimall propounded.

Example: .6739 being propounded, I demand the fraction of a pound *Sterling* repreſented by it; The decimall in the Tablet of *money*, which being leſſe comes neareſt to .6739 is .65, whoſe correſpondent number in that Tablet is 13, which are the *ſhillings* of the number required; Then ſubtracting (by the 1 *Rule* of the 14 Chapter of this Booke) .65 out of .6739, the remainder is 0239, and the neareſt decimall in the ſame Tablet to ·0239 is .0208, whoſe correſpondent number is 5, which are the *pence* of the number required: Laſt of all deducting .0203 out of .0239, the *remainder* is .0031, which gives you in the firſt co-

lumne 3, being the *farthings* of the number required: So that I conclude the intire fraction represented by the *decimall*. .6739, is 13, s. 5, d. 3, f.

13, s. 5, d. 3, f.	.6739
	.65
	.0239
	.0208
	.0031

In like manner 7. 359, C. being reduced by the Tablet of *Averdupois great waight* is 7 $\frac{1}{4}$ C. 12, lb. 4, ounc. And 94. .58, lb. reduced by the Tablet of *Averdupois little waight*; is 94, lb, 9, ounces 6 drammes.

7, C. 1, qu. 12, lb. 4, ounc.	7.359
	25
	109
	107
	002
94, lb. 9, ounc. 6, dram.	94. 58
	56
	02

To finde the value of a Decimall by multiplication.

XIX. *Any decimall being propounded, the value thereof in the known parts of the Integer, may be found without help of the Table of Reduction,* viz. *by Multiplication; for if the decimall given be multiplied (according to the Rules of decimall Multiplication expreſſed in the* 15. *Chapter) by the number of known parts of the next inferiour denomination, which are equall to the Integer, the Product is the value of the decimall propoſed, in that inferiour denomination; and if there happen to be any decimall in the Product, you may in like manner finde the value thereof in the next inferiour denomination, and ſo proceed till you come to the leaſt known parts of the Integer.*

So if the *decimall* ·7365 repreſenting the fraction of a pound *ſterling* be propounded, the value thereof will be found 14,s. 8,d. 3,f. *ferè, viz.*, multiplying the *decimall* .7365 by 20 (the number of the ſhillings in a pound *ſterling*) the Product will be found 14 .73 *ſhillings*. Againe, multiplying the *decimall* ·73 *ſhillings*, by 12 (the number of pence in a ſhilling) the Product will bee 8. 76 *pence*. Laſtly, multiplying the *decimall* ·76. d. by 4 (the number of farthings in a

penny) the Product wil bee found 3. 04 *farthings*. As by the operation in the *Margent* is manifeft. In like manner the value of the *decimall* ·7362 of a pound *Troy* will be found 8 Ounces, 16 penny waight, and 16 Graines *fere*, as by the fubfequent operation is manifeft.

```
·7365
  20
14|7300
  12
 146
  73
 8|76
   4
 3|04
```

```
·7362
  12
 14724
  7362
 8|8344   Ounc.
  20
16|6880   P. w.
  24
 27520
 13760
16|5120   Gr.
```

In

In like manner the decimall .975899 degree will be reduced into $58^{'}:33^{''}:14^{'''}$, &c. that is, 58 minutes, 33 seconds, 14 thirds.

CHAP. XIII.

Of Notation and Addition of Decimals.

1. THe *Notation* of *Decimals* is before shewne in the 24, 25, 26 and 27. *Rules* of the 1 Chapter; but for the better understanding of the practical operations in *decimals*, you may further observe that the order of places in *decimals* is from the left hand to the right, contrary to that of *whole Numbers* which is from the right hand to the left, as will bee manifest by the subsequent *Table*.

I H G F E D C B A	*a b c d e f g h*
9 8 7 6 5 4 3 2 1	. 1 2 3 4 5 6 7 8

Ten 10	.1 Signifieth $\frac{1}{10}$
One hundred 100	.01 that is $\frac{1}{100}$
1000	.001
10000	.0001
100000	.00001
1000000	.000001
10000000	.0000001
100000000	.00000001

The Capitall letters at the head of the precedent *Table* doe ſhew the Order of the places of *Integers*; viz. from the place of *Knits* to the left hand; ſo *A* is the place of *Units* or firſt place, *B* the place of *Tens*, or ſecond place, *C* the place of *Hundreds* or third place, &c. And on the contrary, the ſmall Romane letters doe ſhew the Order of the places of *Decimals* beneath Unity; ſo *a* is the firſt place, or place of *Tenths*, *b* is the ſecond place or place of *Hundreds*, &c. And as the *valors* of the places of *Integers* doe increaſe in a decuple *Ratio* from Unity towards the left hand, *viz.* *B* or the ſecond place is ten times greater in value then *A* the firſt place; alſo *C* or the third place is tenne times greater in value then *B* &c So on the contrary, the *valors* of the places of *decimals*, doe decreaſe in a decuple *Ratio* beneath Unity towards the right hand, *viz.* *a* or the firſt place of *decimals* is tenne times leſſe in value then 1 or Unity, *b* or the ſecond place is ten times leſſe in value then *a*, and *c* is ten times leſſe in value then *b*, &c.

Moreover, as Cyphers in the foremoſt places of *decimals*, are ſometimes neceſſary to diſcover the true Denominator (as

is

is manifeſt by the precedent *Table*, and by the 26 *Rule* of the firſt Chapter:) So on the contrary, cyphers at the end of *decimals* are of no uſe. (*viz.*) .3 is equivalent unto .30, or .300, or .3000, (as is manifeſt by the 7 rule of the 7 chapter) for $\frac{30}{100}$ being reduced to its leaſt termes will be $\frac{3}{10}$ alſo $\frac{3000}{10000}$ will be reduced to $\frac{3}{10}$: The premiſſes being conſidered, and the 24, 25, 26, 27, and 50th. rules of the 1 Chapter diligently obſerved for the writing downe of *decimals*, there will bee no difficulty in *Addition* of *decimals*, or mixt numbers whoſe Fractionall parts are *decimals*, as will be manifeſt by the ſubſequent *Rule*, *viz.*

II. *Place the decimals in rankes orderly one under the other in ſuch manner, that like places may ſtand in one and the ſame down right line, which ſhall rightly bee done, if the points prefixed before each decimall ſtand directly one above another; Then adde them together as is taught in Addition of whole Numbers by the* 10th. *and* 11th. *Rules of the ſecond Chapter: Examples hereof are theſe that follow:* Addition of Decimals.

	.3	25.35	32.
	.752	19.13	19.
	.098	9.073	54.
	.05	6.7	8.75
.65	.926	.05	.198
.0208	.83	24.17	.97
.6708	2.956	84.473	114.918

Here you may observe, that the Number of Tens (if there be any) contained in the first place of the *decimals*, being that next unto the points) is the Number of *Integers* to be carried to the place of *Vnits* or *Integers*.

Chap. XIV.

Of Subtraction of Decimals.

Subtraction of Decimals

I PLace the *decimals* as is directed in the last Chapter, and then proceed as you are taught in *Subtraction* of *whole Numbers* by the third and fourth *Rules* of the third Chapter:

Examples

Examples hereof are theſe that follow:

Out of	.8372	295.094
Take	.7842	78.919
Rem.	.0530	216.175

But here when the *decimals* conſiſt not of equall places towards the right hand, ſupply that defect by annexing Cyphers, or at leaſt by ſuppoſing Cyphers to bee annexed unto thoſe *Decimalls*, in that kinde deficient: Examples hereof are theſe;

.65	24.04338
.04338	.65
60662	23.39338
37.	.3944
.10416	.35
36.89584	.0444

CHAP.

Chap. XV.

Of Multiplication of Decimals.

Multiplication of Decimals.

I. *IN any of the Cases which may fall out in Multiplication of decimals, multiply the Termes given as if they were whole Numbers, according to the Rules prescribed in the fourth Chapter, and cut off always from the Product towards the right hand by a down right line or point, so many places as are jointly in the decimall parts of both the terms given to be multiplied; so is the number cut off toward the right hand the Fractionall part of the Product, and that on the left hand (if any happen) is the Integrall part of the Product: Examples hereof are these that follow:*

12.453	246.25
7.08	35
99624	123125
87171	73875
88|16724	861875
564	·87
·9	·9
507|6	·783

II. *When*

II. *When the Product consists not of so many places as there are places of decimall parts in both the Termes given, (which oftentimes may happen when the Product is a decimall) supply the deficient place or places in the Product, with a Cypher or Cyphers prefixed on the left hand thereof: Examples hereof are these following:*

5. 525	.0375	.0125
.0026	. 05	.025
33150	.001875	625
11050		250
0143650		.0003125

CHAP. XVI.

Of Division by Decimals.

I. *IN any of the Cases which may happen in division by decimals, the dividend being greater then the divisor, the quotient will be either a whole Number or a mixt Number; but being lesse then the divisor, the quotient will be a decimall.*

II. *Cyphers at pleasure (if there bee occasion) are to be annexed, or at least supposed to be annexed to the dividend, to the end*

end that the quotient may bee continued to as many places as is necessary.

III. *The dividend being so prepared, you are to divide it by the divisor as if they were whole Numbers, according to the rules prescribed in the 5 Chapter, and to sever the whole part of the quotient; (if there be any) from the fractionall or broken part, or else to finde the quality of the fractionall part, when there is not any Integer in the quotient, according to the following Rules.*

Division by Decimalls, *viz.*

1. When both the Termes are mixt Numbers, or one of them a whole Number and the other mixt, or when the Dividend is a Decimall and the Divisor a whole or mixt Number.

IV. *The Termes given being both mixt Numbers, or one of them a whole Number and the other a mixt Number, or the dividend being a decimall and the divisor a whole Number or a mixt number; the first figure in the quotient (in such Cases) will be of the same place or degree, with that Figure or Cypher of the dividend which at first demand standeth, or ht least is supposed to stand directly over the place of Vnits in the divisor.*

So if 1524.25 be divided by 28.75, the *quotient* will be found 53.0173, &c. for the place of *Tens* in the *dividend* (that is the second place of the *Integers* towards the left hand) standing over the place of *Vnits* in the *divisor*, (that is, the first

first place of the *Integers*) at the first demand, shewes that the first Figure in the *quotient* will bee in the place of *Tens*, and therefore the *Integrall part* of the *quotient* must consist of two of the formost places, and the rest will bee a *decimall*: In like manner if 5.3672 bee divided by 17, the *quotient* will bee found .3157, *&c.* For the place of *Tenths* (or first place of a *decimall*) in the *dividend*, standing over the place of *Vnits* in the *divisor*, (that is, over the first place of the *Integers*,) at the first demand, shewes that the first Figure of the *quotient*, will bee the place of *Tenths*, (or first place of a *decimall*:) Also if 1 or an *Integer* bee divided by 26. 3, the *quotient* will bee .038, *&c.* And if .35673 bee divided by 44, the *quotient* will bee .0081, *&c.* The operation of the said examples will be as followeth:

28.75)1524.250000(53.0173,&c.
1437 5
8675
8625
5000
2875
21250
20135
11250
8625
2625

17)5.3672(.3157.
5 1
26
17
97
85
122
119
3

26.3)1.0000(.038,&c.
789
2110
2104
6

44).35673(.0081,&c.
352
47
44
3

2. When the Dividend is a whole Number or mixt.

V. *When the dividend is a whole or mixt Number and the divisor a decimal, observe how many places will arise in the quotient, in dividing the whole part of the dividend increased on the right hand with so many places as are in the divisor, for the same Number of places will be in the Integrall part of the quotient in this Case.*

So

So if 19 . 35 bee divided by .032, the *quotient* will be found 604 . 6875, for if unto 19 the *whole part* of the *dividend* be annexed three places (being the Number of places in the *diviſor*) it will conſiſt of 5 places, in dividing whereof by 32 the ſignificant figures in the *diviſor*, it is manifeſt there will ariſe three places in the *quotient*, which ſhewes that the *Integrall part* of the *quotient* will conſiſt of three places: Alſo if 2481 be divided by .25, the *quotient* will bee 9924. The operation of the ſaid examples will be as followeth;

```
.032) 19.3500000 (604.6875
      192
      ---
       150
       128
       ---
        220
        192
        ---
         280
         256
         ---
          240
          224
          ---
           160
           160
           ---
             0

 .25)2481.00(9924
     225
     ---
      231
      225
      ---
       60
       50
       ---
       100
       100
       ---
         0
```

3. When the Termes given are Decimals, the Dividend being the greater Terme.

VI. *When the Termes given are both decimals, the dividend being the greater, observe how many places will arise in the quotient, in dividing so many of the formost places of the dividend, as there are places in the divisor, for the same number of places will be in the Integrall part of the quotient in this Case.*

So if 4375 be divided by ·03, the *quotient* will be 14 .583, &c. Also if ·6880 be divided by .32 the *quotient* will be 2.15. The operation will be as followeth.

·03). 43750(14583, &c.

.32). .6880(2|15

64

48

32

160

160

0

4. When the Termes given are Decimals, the Dividend being the lesser Terme.

VII. *When the Termes given are both decimals consisting of equall places, the dividend being the lesser Terme, place the dividend as a Numerator, and the divisor a denominator, so is such vulgar Fraction the quotient; But if the Termes given consist not of equall places, supply the*

pla

place or places defective in either of the Termes, by annexing a Cypher or Cypher's on the right hand, and then proceed as before.

So if .25 be propounded to be divided by .75 the *quotient* will be $\frac{25}{75}$. Also if .3 be given to be divided by .9654 the *quotient* will be $\frac{3000}{9654}$, which *vulgar Fractions*, (if occasion serve) may bee reduced into *decimals* by the second Rule of the 12 Chapter.

CHAP. XVII.

The Extraction of the Square Roote.

I. *THus much of* Numeration. *Now followes the* Extraction *of* Roots, viz. *of the* Square *and* Cube.

II. *The* Extraction *of the* Square-root *is that by which having a Number given wee finde out another Number, which being multiplyed by it selfe produceth the number given.*

III. *In the* Extraction *of the* ſquare-roote *the Number propounded is always conceived to bee a* Square *number, that is, a number of certain little* Squares *comprehended within one intire great* ſquare, *and the* Roote *or number required is the ſide of that great* Square. What the Extraction of the *Square roote* is, will readily appeare by this *Diagramme*, before produced in the 5 rule of the 5 Chapter: For as in *Multiplication* having two *ſides* given, we demand the *Content*, and in *diviſion* having the Content, and one of the ſides propounded, the other *ſide* is required: So in the Extraction of the *Square roote* having a *Square content* given, we demand the *ſide*, which being *multiplyed* by it ſelfe conſtitutes that *Square*: Thus the *Square number* 25 being given (as in the *Diagramme*) his *roote* demanded is 5, for 5 times 5 is 25.

A Square number.

IV.

IV. Square numbers *are either* single *or* compound.

V. *A* single Square number *is that, which being produced by the* multiplication *of one single figure by it selfe, is alwayes lesse then* 100. So 25 is a *single Square number* produced by 5, multiplyed by it selfe. A single square number.

VI. *All the* single Square numbers *together with their respective* rootes *are expressed in the* Table *following*;

1	4	9	16	25	36	49	64	81
1	2	3	4	5	6	7	8	9

Here in the uppermost rank of the Table are placed the *single* Square numbers of every particular *figure*, and in the other their respective *roots*; And therefore if it were demanded what is the *Square roote* of 36, the *Answere* would bee 6. so the *square roote* of 4 is 2, the *square roote* of 9 is 3, &c.

VII. *When a* Square number *is given, that exceeds not* 100, *and yet is none of the* Square numbers *mentioned in the* Table, *for his* roote *you are to take the* roote *of*

the Square number, *that being leſſe, yet comes neareſt unto it:* So 45 being given, the *roote* that belongs unto it is 6, and 10 being given, his correſpondent *roote* is 3.

A Compound ſquare number.

VIII. *A Componnd* Square number *is that, which being produced by a* number *(that conſiſts of mo places then one) multiplied by it ſelfe, is never leſſe then* 100. So 1024 is a *Compound* ſquare number produced by the multiplication of 32 multiplied by it ſelf.

IX. *To prepare any* Square number *given for* Extraction, *ſubſcribe a Point under each other figure beginning with the laſt firſt:* So 1024 being given, you are to ſubſcribe the *Points* thus, 1024. And ſo many *Points* as are in that manner ſubſcribed, of ſo many figures the *roote* demanded will conſiſt.

The Extraction.

X. *Having thus prepared your number, you may ſee it diſtributed by the points into ſeverall* Squares: So in the laſt example 10 is the firſt *Square*, and 24 the ſecond.

XI. *Having drawn a quotient in the margent, finde the* roote *of the firſt ſquare, and place it in the quotient:* So I finding by the ſeventh rule aforegoing 3, to be the

cor-

correſpondent *roote* of 10, I write 3 in the quotient, and then the worke will ſtand *thus*, 1024 (3.

XII. *Subſcribe the ſquare of the figure placed in the Quotient under the firſt ſquare of the number given,* as you ſee in the *Margent.*

1024 (3
9

XIII. *Subtract the ſquare of the figure placed in the quotient, out of the firſt ſquare of the number given, and having placed the remainder above that firſt ſquare, cancell the figures out of which the Subtraction was made:* this done, the worke will ſtand as it is in the *Margent.*

1
1024 (3
9

XIV. *Draw a line under the worke, and having doubled the* roote, *place it under the firſt figure of the next ſquare:* As in the *example.*

XV. *Demanding how often the firſt Figure of the double* roote *towards the left hand is contained in the remaining figures of the ſquare Number placed above it, and obſerving in that behalfe the Rules before taught in Di-*

1
1024 (3
9
6

vision, write the Answer in the Quotient, as also under the line after the double roote: So if you aske how often 6 is in 12. the *Answer* is 2. wherefore I write 2 in the *Quotient*, and likewise under the *line* after 6. See the Example in the *Margent.*

See the 5. Chapter.

	1
1024	(32
	9
	62

XVI. *Multiply the number under the line by the Figure last placed in the Quotient, and writing the Product under that number, Subtract it out of the Figures of the Square number placed above it, and then proceed as you are directed in the 13th Rule aforegoing.*

So 62 multiplied by 2, the Product is 124, which if I *Subtract* out of 124 the Figures of the *Square number* placed above it, the *remainder* is 0. And thus the whole worke being finished, the *Square roote of* 1024, the number propounded, is found to be 32.

	100
1024	(32
	9
	62
	124

See the 5. Chapter.

But here observe by the way, that when the Product exceeds the number placed above it, the worke is erroneous, and then you are to reform it by placing a lesse Figure

Figure in the quotient, as you were taught before in *Division*.

XVII. *When after the whole worke is finished, any Figures remaine of the last Subtraction, they are the Numerator of a Fraction, which hath the* roote *doubled with an Vnite added unto it for his denominator, and is to bee annexed unto the number in the Quotient, as the broken part of the* roote *required.*

So if the *Square roote* of 43623 were demanded, it would be found 208 $\frac{359}{417}$ as appeares by the *Example* hereunto annexed, for having distinguished the number given into severall *Squares* by Points, first I demand the *Square roote* of 4 the *first* square, which I finde by the *sixth* rule of this Chapter to bee 2, wherefore placing 2 in the *Quotient*, and 4 the *Square* thereof under 4 the *first* square, I *subtract* 4 out of 4, and finding nothing to remain I *cancell* 4 the *first* square, placing 0 above it; then drawing a *line* under the worke, I *double* 2 the roote, and place the double thereof, *viz.* 4.

```
00359
43623 (208 359/417
4
---------
40
---------
  408
  3264
```

under

under 3 the first Figure of the *next* square; after this I demand how often 4 the *double* roote is contained in 3 the *figure* placed above it, and not finding it once contained in it, I place 0 in the Quotient, (according to the 11th. rule of the 5th. Chap.) and likewise under the line after the *double roote*; and because the Product of 40 multiplied by 0 (the last Figure placed in the Quotient) is 0, 36 the *figures* out of which it ought to bee deducted remain the same without *alteration*; wherefore *drawing* another line, and doubling 20 the roote, I *place* 40 the double roote under 2 the *first* figure of the *last* square; then I *demand* again how often 4 the *first* figure of the *double* roote is contained in 36 the figures above it; and though it bee *nine* times in it, yet dare I take but 8, which I write in the Quotient (according to the 7. rule of the 5. Chapter) and likewise after 40 under the *lowest* line; This done, I multiplying as before 408 the number under the *line* by 8 the *last* figure placed in the Quotient, the product is 3264, which if I *subtract* out of 3623 the figures placed above it, the *remainder* is 359; So that at last I finde 208 to be the whole part of the *roote* demanded; and as for the

Fraction

Fraction annexed 359 is the *Numerator* thereof, and 417 the *denominator*; For 208 the roote being doubled is 416, whereunto if you adde an *unite* (according to this rule) the ſumme is 417; and therefore the *Number* ſought for in this demand is $208\frac{132}{417}$ as before in the *Example*.

XVIII. *The extraction of the Square* roote *is proved by multiplying the* roote *by it ſelfe*; for that done the product will be equall to the number *given*; So in the firſt *example* of this Chapter, 32 being multiplied by it ſelfe produceth 1024, the number *propounded*; But when the Quotient hath a fraction annexed, adde the *numerator* of that fraction to the product, and then the ſumme will bee equall to the number *given*: So in the laſt *Example* 208 being multiplied by it ſelfe produceth 43264, unto which if you adde 359, the *Numerator* of the fraction annexed, the ſumme is 43623 the Number *propounded*. The Proof.

XIX. *Sometime to finde the broken part of the* roote *more exactly, a competent number of paires of Cyphers, viz. either* 00, 0000, 000000, *or* 00000000, *&c. are annexed unto the number given, and*

Ram. Geom. lib. 12. Elem. 8.

in

in this Case the said broken part of the roote *is alwayes a decimall consisting of so many places as there were paires of Cyphers annexed.*

So if 43623 were given, as before, to finde the roote thereof (according to this Rule) annexe Cyphers unto it in this manner, 43623000000, And then if you ex-

```
      2550
   003595604
   43623000000 (208. 861.
   4
   40
    408
    3264
     4168
     33344
      41766
      250596
       41772
```

tract it accoording to the *rules* aforegoing you shall finde the roote thereof to bee 208.861, which is *equivalent* to 208 $\frac{152}{417}$ for the *whole* parts are the same in both the

the *rootes*, and as for the *broken* parts $\frac{112}{417}$ and $\frac{861}{1000}$ or .861 have the ſame value; the whole operation is apparent by the *example* premiſed. *Again*, if 10 were propounded to bee extracted, you muſt prepare it thus, 10000000000000, and then the roote thereof in this manner extracted will bee,

$$3\frac{1622776}{10000000}$$

which may alſo bee written thus, 3. 1622776 according to the laſt rule of the 1 chapter of this Booke.

117
2394456
10000000 &c. (3.162, &c.
. . .
9
61
626
3756
6322
12644

See here part of the worke which may give you a light and underſtanding of the reſt: And here *obſerve* that in this caſe the more *Cyphers* you annexe unto the num-

ber

ber given, the more just and exact the *operation* will prove.

Lastly, as touching the *Points*, by which the number given ought to bee marked, proceed as you are before directed in the 9 rule of this Chapter (beginning *first* with the *last* Figure of the number given) as though no *Cyphers* at all were annexed; and then subscribe likewise *Points* under each other of the *Cyphers* annexed, proceeding from the *last* Figure of the number given towards the *right* hand: See the examples.

To extract the square roote of a Fraction.

XX. *The* Square roote *of a Fraction is found in this manner*, viz. *extract the* Square roote *of the* Numerator (*according to the aforegoing Rules of this chapter*) *which* roote *shall bee a new* Numerator. *Also the* Square roote *of the denominator is a new denominator, so is the new Fraction the* Square roote *of the Fraction given:*

Thus the *Square roote* of $\frac{9}{16}$ is $\frac{3}{4}$. *viz.* the *Square root* of 9 is 3 for a new Numerator; Also the *Square roote* of 16 is 4 for a new denominator.

Of Fractions incommensurable to their square roots.

XXI. *When either the Numerator or denominator hath not a perfect* Square root, *viz. when such Fraction is incommensurable*

rable to its ſquare roote, *the* ſquare roote *of ſuch Fraction is expreſſed by prefixing this Character* ℒ *or* ℒq. *before the Fraction given:*

So the *ſquare roote* of $\frac{12}{16}$ is thus expreſſed ℒ$\frac{12}{16}$, or *thus* ℒq $\frac{12}{16}$ becauſe it is inexpreſſible by number: But here you are to obſerve, that if the *Fraction* whoſe *ſquare roote* is required, be not in its *leaſt Termes*; it is firſt of all to be reduced into its *leaſt Termes* by the 3 *Rule* of the 7 chapter; for oftentimes it happens, that although the former be *incommenſurable* to its *roote*, yet the latter may bee *commenſurable*; So in this *Fraction* $\frac{8}{18}$ each Tearme is *incommenſurable* to its *ſquare roote*, but the ſaid $\frac{8}{18}$ being reduced to its *leaſt Termes* $\frac{4}{9}$, there will be found in each Terme a *commenſurable roote*; *viz.* the *ſquare roote* of 4 is 2 for a new Numerator, and the *ſquare roote* of 9 is 3 for a new Denominator, ſo is $\frac{2}{3}$ the *ſquare roote* of $\frac{4}{9}$ (equivalent unto $\frac{8}{18}$)

XXII. *The* ſquare roote *of a Fraction which is incommenſurable to its* roote *may be found neare, in this manner, viz. Reduce the Fraction propoſed into a decimall by the* 2 *Rule of the* 12 *Chapter: the more places are in the decimall, the nearer will the* roote *be found, but the decimall muſt*

To extract the ſquare root neare, of a Fraction incommenſurable to its ſquare roote.

must consist of an even number of places, viz. *either of two, foure, six, eight or ten, &c. places; Then extract the* square root *of that decimall as if it were a whole number according to the Rules aforegoing, which* roote *found shall bee a decimall expressing neare the* square roote *of the fraction proposed.*

So if the *square roote* of $\frac{13}{16}$ bee required neare, reduce the said $\frac{13}{16}$ into a Decimall (by the 2. *rule* of the 12. Chapter) which will be found .81250000, &c. Then extracting the *square roote* thereof as if it were a whole number, it will bee found .9013 *ferè*.

To extract the square roote of a mixt number.

XXIII. *The* square roote *of a mixt number commensurable to its* roote, *is found in the same manner as in the* 20. *rule of this Chapter, the mixt number being first reduced into an improper Fraction by the* 9. *rule of the* 7. *chapter.*

So the *square roote* of $34\frac{11}{64}$ will bee found $5\frac{3}{8}$ viz. $34\frac{11}{64}$ being reduced into the improper fraction $\frac{2202}{64}$, the *square root* of the Numerator 2209 will be 47 for a new Numerator; Also the *square roote* of the Denominator 64 is 8, for a new Denominator, so is found $\frac{47}{8}$ which (by the 12. rule of the 7. Chapter) is $5\frac{3}{8}$ the *square*

roote

roote ſought. And here the ſame Caution is to be obſerved as in the 21. *Rule* of this Chapter; *viz.* the fractionall part of the mixt number, or the improper fraction equivalent unto the mixt number, muſt be in the *leaſt Termes* before any extraction be made.

XXIV. *When the mixt number given is incommenſurable to its* ſquare roote, *prefix this Character before it*, viz. *ſ or ſq.* So the *ſquare roote* of $7\frac{2}{3}$ will be thus expreſſed; *ſ* $7\frac{2}{3}$ or *ſq.* $7\frac{2}{3}$: But if you deſire to finde the *ſquare roote* neare, of a mixt number *incommenſurable* to its *roote*, reduce the fractionall part of the mixt number into a *Decimall* of an even number of places, as in the 22. *rule* of this chapter, and annex the *Decimall* ſo found unto the whole part of the mixt number; Then eſteeming the ſaid whole number and *Decimall* as one intire number, extract the *ſquare roote* thereof according to the afore going *rules* of this chapter, and from the root found, cut off alwayes to the right hand, ſo many places as there are points over the Decimall annexed, which number ſo cut off ſhall be a *Decimall*, ſhewing the fractionall part of the root, and that on the left hand ſhall bee the whole part of the

To finde the Square root neare, of a mixt Number incommenſurable to its roote.

roote; So the *ſquare roote* of $7\frac{2}{3}$ will be found 2.7688 *fere*.

Chap. XVIII.

The Extraction of the Cube roote.

I. *The Extraction of the cube roote is that, by which having a number given, we finde another number, which being firſt multiplied by it ſelfe, and then by the Product produceth the number given.*

A Cube Number.

II. *In the extraction of the cube roote the number propounded is alwayes conceived to be a cube number, that is, a certain number of little cubes comprehended within one intire great cube, and the roote or number required is the ſide of the ſquare, which conſtitutes that great cube:* What a *cube* is may bee well expreſt by a *die*, which indeed is a little *cube* it ſelfe: wherefore if you place foure *dice* in a ſquare form, that is, laying two and two in a ranke you ſhall have a ſquare containing foure *dice*, upon which if you yet erect ſuch another ſquare of *dice*, you ſhall have

have a great intire *cube* comprehending two times foure, that is, 8 *dice* or little *cubes*; And here 8 is the *cube number* given, and 2 is the *roote*, or number required: In like manner if you ranke 25 *dice* in a ſquare form, *viz.* laying 5 in a ranke, you have a ſquare containing 25 *dice*, now upon this ſquare of *dice* if you erect foure other like ſquares, you ſhall have a great intire *cube* comprehending 5 times 25, that is, 125 little *cubes*; and in this caſe 125 is the *cube number* propounded, and 5 the *roote*, or number required.

III. *A cube number is either ſingle or compound.*

A ſingle Cube Number.

IV. *A ſingle cube number is that, which being produced by the multiplication of one ſingle figure firſt by it ſelfe, and then by the Product, is alwayes leſſe then* 1000. So 125 is a *ſingle* cube number produced by 5 multiplied *firſt* by it ſelfe, and *then* by 25 the Product; for 5 times 5 is 25; and 5 times 25 is 125.

V. *All the ſingle cube numbers, and ſquare numbers, together with their reſpective rootes, are expreſſed in the Table following.*

1	8	27	64	125	216	343	512	729
1	4	9	16	25	36	49	64	81
1	2	3	4	5	6	7	8	9

Here in the uppermoſt ranke of the *Table* are placed the *ſingle cube numbers* of the particulars figures 1,2,3,4,5,6,7,8,9; in the next the *ſquares* of thoſe figures, and in the loweſt ranke the *figures* themſelves, being the reſpective *rootes* of the cubes and ſquares in the uppermoſt rankes; and therefore the *cube roote* of 125 being demanded, the *anſwer* is 5, and the *cube roote* of 216 being required, the Table will give you 6, and ſo of the reſt.

VI. *When a cube number is given, that exceeds not* 1000, *and yet is none of the Cube numbers mentioned in the Table; for his roote you are to take the roote of the cube number, that being leſſe comes neareſt unto it.* So 157 being given, the *roote* that belongs unto it is 5.

A compound Cube Number.

VII. *A compound cube number is that, which being produced by a number, that conſiſts of moe places then one, firſt multiplied by it ſelfe, and then by the Product, is never leſſe then* 1000. So 157464 is a *compound cube number*, being produced by

by 54, multiplied *first* by it ſelfe, and *then* by 2916 the product, for 54 times 54 is 2916, and then 54 times 2916 is 157464, the *compound cube number* propounded.

VIII. *To prepare a cube number for extraction ſubſcribe a point under every third figure from the laſt, placing one alſo under it*: So 157464 being given, you are to ſubſcribe the points as in the margent, and ſo many points as are in that manner ſubſcribed, of ſo many Figures the *roote* demanded will conſiſt.

157464

IX. *Having thus prepared your number, you may ſee it diſtributed by the points into ſeverall Cubes*: So in the ſame *example* 157 is the *firſt* cube, and 464 the *ſecond*. The Extraction.

X. *Having drawne a Quotient in the Margent finde the* roote *of the firſt cube, and place it in the quotient*: So I finding (by the *ſixth* Rule of this Chapter) 5 to bee the correſpondent *roote* of 157, I write 5 in the Quotient, and then the worke will ſtand *thus*: The firſt Operation.

157464(5

XI. *Subſcribe the cube of the* roote *under the firſt cube of the number given*:

So 125 being the *cube* of 5 the roote (by the 5 Rule of this Chapter) I write it under 157 the *first cube* of the number given thus:

157464 (5
125

XII. *Subtract the cube of the* roote *out of the first cube of the number given, and having placed the Remainder above the first cube, cancell the Figures of the same, out of which the Subtraction is made*, this done, the worke will ſtand thus:

32
157464 (5
125

The ſecond Operation.

XIII. *Draw a line under the worke, and having trebled the* roote, *ſubſcribe it under the ſecond Figure of the next cube*, as followeth in the *example*, for three times 5 being 15 I write it under 6 the *ſecond* Figure of the next *cube*.

32
157464 (5
125
15

XIV. *Multiply the triple number by the* roote, *and place the Product under the firſt Figure of the ſecond cube, which product is more particularly called the Di-*

viſor:

viſor: So 15 the *triple* number multiplied by 5, the Product is 75, which I place under 4 the *firſt* Figure of 464 the *laſt* cube of the number given, and this 75 is termed the *Diviſor*; *obſerve* the worke in the *Margent*.

32
257464 (5
125
15
75

XV. *Demand how often the firſt Figure of the Diviſor is contained in the remaining Figures of the cube number placed above it, and obſerving in that behalfe the rules before taught in Diviſion, write the Anſwer in the quotient:* So if I aske how often 7 the firſt Figure of the *Diviſor* is in 32 the remaining figures of the cube number placed above it, the *anſwer* will be 4, wherefore I write 4 in the Quotient, and then the worke ſtands, as you ſee it in the *Margent*.

See the Rules of the 5. Chapter.

32
257464 (54
125
15
75

XVI. *Draw again another line under the worke, and ſubſcribe the cube of the Figure laſt placed in the quotient under*

the last Figure of the second cube of the number given: So 64 being the *cube* of 4, I write it under 4 the *last* figure of the *last* cube of the number given, and then the worke stands thus:

```
  32
157464 (54
 125
 ---
  15
  75
 ---
  64
```

XVII. *Multiply the Figure last placed in the quotient first by it selfe, and then the product by the triple number; this done, subscribe the last Product under the triple number.*

So 4 being multiplied by it selfe the product is 16, which being againe multiplied by 15 the *triple* number, the product is 240, this therefore I place under the *triple* number, thus:

```
  32
157464 (54
 125
 ---
  15
  75
 ---
  64
 240
```

XVIII.

XVIII. *Multiply the diviſor by the figure laſt placed in the quotient, & write the product under the diviſor*: So 75 being multiplied by 4 the product is 300, which I write under 75 the *diviſor*, as you may obſerve in the *example*.

32
157464 (54
125
15
75
64
240
300

XIX. *Drawing yet another line under the work adde the 3 laſt numbers together, and the ſumme thereof deduct out of the remaining Figures of the number given, proceeding in that behalfe, as you are directed in the* XII. *Rule aforegoing*: So the *ſum* of the 3 laſt numbers as they are ranked in the work is 32464, which if you ſubtract out of 32464 the remaining figures of the number given, the remainder is 0; And then the whole worke being finiſhed, the *cube root* of 157464 the number propounded is found to be 54, and thus if the number ſhould conſiſt of never ſo many *cubes*,

32000
157464 (54
125
15
75
64
240
300
32464

See the 7. Rule of the 5. Chapter: and the 16 Rule of the laſt Chapter.

they

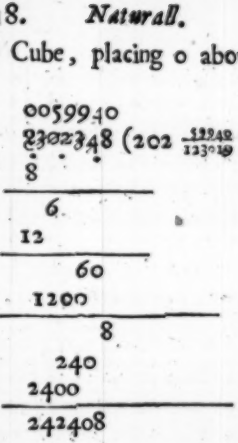
they are all resolved as the last cube of the number given; But here observe by the way, that when the summe of the three last numbers is greater then the remaining Figures above it, the worke is erroneous, and then you are to reforme it by placing a lesse Figure in the quotient, as you were taught before in *Division*, and in the extraction of the *square roote*.

XX. *When after the whole worke is finished any Figures remain of the last subtraction, they are the numerator of a fraction, which hath the triple roote, and the square of the roote trebled with an Vnity added together for his denominator, and is to be annexed unto the number in the quotient as the broken part of the number required*: So if the *cube roote of* 8302343 bee demanded, you shall finde it 202 $\frac{52942}{1230129}$ as you may observe by the operation hereunto annexed. For having distinguished the Number propounded into severall cubes by points; First I demand the cube roote of 8 the first cube, which I finde by the 5 rule of this Chapter, to bee 2, wherefore placing 2 in the quotient, and 8 the cube thereof under 8 the first cube, I subtract 8 out of 8, and finding nothing to remaine, I cancell 8

The first Operation.

the

the firſt Cube, placing 0 above it.



Then drawing a Line under the worke, and *trebling* 2, I place 6 the *treble* thereof under 0 the *ſecond* Figure of the next *Cube*. Againe, multiplying 6 the *treble* Roote by 2 the roote, I place 12 the Product thereof (otherwiſe termed the *Diviſor*) under 3 the *firſt Figure* of the ſame Cube; after this I demand how often 1 the firſt Figure of the *Diviſor* is contained in 0 the Figure or note above it, and not finding it once contained in it, I write 0 in the Quotient (according to the 11th. Rule

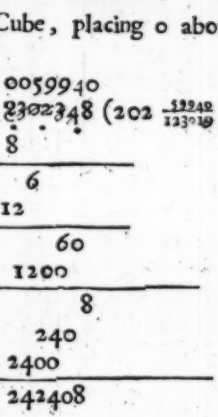
The ſecond Operation.

they are all resolved as the last cube of the number given; But here observe by the way, that when the summe of the three last numbers is greater then the remaining Figures above it, the worke is erroneous, and then you are to reforme it by placing a lesse Figure in the quotient, as you were taught before in *Division*, and in the extraction of the *square roote*.

XX. *When after the whole worke is finished any Figures remain of the last subtraction, they are the numerator of a fraction, which hath the triple roote, and the square of the roote trebled with an Vnite added together for his denominator, and is to be annexed unto the number in the quotient as the broken part of the number required:* So if the *cube roote of* 8302348 bee demanded, you shall finde it 202 $\frac{59942}{1230129}$, as you may observe by the operation hereunto annexed. For having distinguished the Number propounded into severall cubes by points; First I demand the cube roote of 8 the first cube, which I finde by the 5 rule of this Chapter, to bee 2, wherefore placing 2 in the quotient, and 8 the cube thereof under 8 the first cube, I subtract 8 out of 8, and finding nothing to remaine, I cancell 8 the

The first Operation.

the first Cube, placing o above it.



Then drawing a Line under the worke, and *trebling* 2, I place 6 the *treble* thereof under o the *second* Figure of the next *Cube*. Againe, multiplying 6 the *treble* Roote by 2 the roote, I place 12 the Product thereof (otherwise termed the *Divisor*) under 3 the *first Figure* of the same Cube; after this I demand how often 1 the first Figure of the *Divisor* is contained in o the Figure or note above it, and not finding it once contained in it, I write o in the Quotient (according to the 11th. Rule

The second Operation.

Rule of the fifth Chapter.) And now, becauſe the *ſumme* of the three Numbers, which ought to have beene produced by the multiplication of 0, the *laſt Figure* placed in the Quotient amount to 0, theſe Figures 302. out of which that *ſumme* ſhould have beene ſubtracted remaine the ſame without *Alteration*: wherefore drawing another Line under the worke, and *trebling* 20 the Roote, I place 60 the *treble* thereof under 4 the ſecond Figure of the laſt Cube: Likewiſe multiplying 60 the *treble* Number, by 20 the Roote, I place 1200, the Product (being alſo the next *Diviſor*) under 3 the *firſt Figure* of the ſame Cube. Then I demand *as before* how often 1 the firſt Figure of the *Diviſor* is in 3 the Figure above it, and though it bee three times contained in it, yet dare I take but 2 (according to the ſeaventh Rule of the fifth Chapter) which I write likewiſe in the Quotient.

The third Operation.

Again, drawing a third Line under the worke, I take 8, which is the *Cube* of 2 the laſt Figure placed in the Quotient, and place it in the ranke of 8 the laſt Figure of the laſt Cube. In like manner multiplying the ſame 2, *Firſt* by it ſelfe, and

and then 4 the Product thereof by 60 the *triple* Number, I write 240 the laſt Product under 60 the *triple* Number.

Laſt of all, multiplying 1200 the laſt *diviſor* by the ſame 2, I write 2400 the Product under 1200 the *Diviſor*; all this performed, the *ſumme* of theſe three Numbers, *viz.* 8, 240, and 2400 as they ſtand in the worke is 242408, which being *ſubtracted* out of 302348 the Figures above, there *remains* 59940 of the laſt *Subtraction*. The worke being thus farre proſecuted 202 are found to bee the whole part of the Roote required, and as for the *Fraction* annexed, 59940 the Figures remaining are the *numerator* thereof, and 123019 the denominator; for 202 the root being trebled is 606, and the *Square* thereof is 40804 (for 202 times 202 is 40804) which *Square* being trebled is 122412: I ſay therefore theſe three, *viz.* 606 the triple Roote, 122412 the Square of the Roote trebled, and 1 being added together, the *ſumme* is 123019 the *Denominator* of the *Fraction* annexed, *as aforeſaid.*

XXI. *The Extraction of the Cube Roote is proved by multiplying the Roote by* The proofe,

by his Square: For the Product will bee equall to the Number given: So in the first *example* 54 the Roote multiplyed by 54 produceth 2916 his *Square*, which being againe multiplyed by 54, the Product is 157464 the *Number given:* But when the Quotient hath a *Fraction* annexed, adde the *Numerator* of the fraction to the last Product, and so the *Summe* will likewise equall the *Number given*, as in the last example 202 being multiplied by 202, the Product is 8242408, unto which if you adde 59940 the *Numerator* of the *Fraction* annexed, the *summe* is 8302348 the *Number propounded.*

Ram. Geom. L. 24. Elem. 6

XXII. *The broken part of the* Cube Roote *may likewise bee found out by annexing a competent Number of Ternaries of Cyphers*, videlicet, *either* 000, 000000, *or* 000000000, *&c. Cyphers unto the Number given; and in this Case the broken part annexed is always a decimall*; as in the Extraction of the Square Roote: So likewise here, the *broken part* of the Cube Root may be the more exactly discovered by annexing *Cyphers* unto the Number given: So 8302348 being propounded *as before*,

to

to find the Cube Root thereof (according to this Rule) annexe *Cyphers* unto it in this manuer, 8302348000000000, &c. And then proceede as you are directed by the *Patterne* following, in which although you see but part of the worke performed, yet by it you may easily understand how to finish the rest.

1042

1042
10878507
00599940176008
8302348000000, &c. (202.48, &c.
8
——— - - - - - - - - *Oper.* II.
6
12
——— - - - - - - - - *Oper.* III.
60
1200
———
8
240
2400
———
242408
——— - - - - - - - - *Oper.* IV.
606
122412
———
64
9696
489648
———
49061824
——— - - - - *Oper.* V, &c.
6072
12289728
———
512
388608
98317824
———
9835668992

XXIII. *The* Cube roote *of a Fraction is found in this manner*, viz. *Extract the* Cube roote *of the Numerator* (*according to the aforegoing Rules*) *which* roote *ſhall be a new Numerator*; *Alſo the* Cube root *of the* Denominator *is a new* Denominator, *ſo is the new Fraction the* Cube roote *of the Fraction given.* To extract the Cube roote of a Fraction.

Thus the *Cube roote* of $\frac{8}{27}$ is $\frac{2}{3}$, *viz.* the *Cube roote* of 8 is 2 for a new Numerator: Alſo the *Cube roote* of 27 is 3 for a new Denominator.

XXIV. *When either the Numerator or Denominator hath not a perfect Cube root, viz. when ſuch Fraction is incommenſurable to its Cube roote, the Cube roote of ſuch Fraction is expreſſed by prefixing this Character &c. before the Fraction given.* Of Fractions incommenſurable to their Cube roots.

So the *Cube roote* of $\frac{2}{3}$ is thus expreſſed &c. $\frac{2}{3}$. But here you are to obſerve that if the *Fraction* whoſe *Cube roote* is required, be not in its *leaſt Tearmes*, it is firſt of all to bee reduced into its *leaſt Termes* by the 3. rule of the 7. Chapter: for although the former be *incommenſurable* to its *roote*, yet the latter may be *commenſurable*; ſo in this *Fraction* $\frac{16}{54}$ each Terme is *incommenſurable* to its *Cube roote*, but the

said $\frac{16}{54}$ being reduced to its *least Terms* $\frac{8}{27}$, there will bee found in each Terme a commensurable *Cube roote*, as is manifest by the last *Rule*.

To find the Cube roote neare of a Fraction incommensurable to its Cube roote.

XXV. *The cube roote of a Fraction which is incommensurable to its roote, may be found neare, in this manner*, viz. *reduce the Fraction proposed into a Decimall by the* 2. *rule of the* 12. *chapter, the more places are in the decimall, the nearer will the roote be found, but the decimall must consist of ternaries of places*, viz. *either of three, sixe, nine, or twelve &c. places; Then extract the cube roote of that decimall as if it were a whole Number, according to the aforegoing Rules, which roote found shall be a decimall expressing neare the cube roote of the Fraction proposed:*

So if the cube roote of $\frac{2}{3}$ bee required neare, reduce the said $\frac{2}{3}$ into a decimall (by the 2 Rule of the 12. chapter) which will be found, 666666666666, &c. then extracting the cube roote thereof as if it were a whole number it will bee found ,8735 *ferè*.

To extract the Cube roote of a mixt number.

XXVI. *The cube roote of a mixt number commensurable to its roote is found in the same manner as in the* 23. *Rule of this chapter, the mixt number being first re-*

duced

ted into an improper Fraction by the 9. rule of the 7. chapter.

So the cube roote of $12\frac{12}{27}$ will be found $2\frac{1}{3}$, *viz.* reducing $12\frac{12}{27}$ into an improper Fraction it will bee $\frac{324}{27}$, whose cube roote will be found $\frac{3}{3}$ (by the 23. rule of this chapter,) which being reduced according to the 12. rule of the 7. chapter, is $2\frac{1}{3}$ the cube roote sought. And here the same caution is to be observed as in the 24 rule of this chapter, *viz.* the Fractionall part of the mixt number, or the improper fraction equivalent unto the mixt number, must be in the *least Termes* before any extraction be made.

XXVII. *When the mixt number whose cube roote is required, is incommensurable to its cube roote, prefixe this character before it*, viz. *&c. so the cube roote of* $2\frac{1}{8}$ *will be thus expressed &c.* $2\frac{1}{8}$; But if you desire to finde the cube roote neare, of a mixt number *incommensurable* to its root, reduce the fractionall part of the mixt number into a *decimall* as in the 25. rule of this chapter, and annexe the *decimall* so found, unto the whole part of the mixt number; Then esteeming the said whole number and *decimall* as one intire number, extract the cube roote thereof according

To finde the Cube roote neare of a mixt number incommensurable to its Cube roote.

to the aforegoing rules of this chapter, and from the roote found, cut off alwayes to the right hand ſo many places as there are points over the ſaid *decimall* annexed, which number ſo cut off ſhall be a *decimal* ſhewing the fractionall part of the roote, and that on the left hand ſhall be the whole part of the roote; ſo the cube roote of 3 $\frac{1}{8}$ will be found 1. 334 *ferè*.

XXVIII. I might here proceed to ſhew the extraction of other *roots*, as the *Biquadrate*, *Quadrato cube*, *Cubo cube* &c. but in regard they ſerve more for curioſity then uſe, being exceeding tedious in operation, and cannot naturally be underſtood without the knowledge of *Algebra* in *Species*, I ſhall onely touch upon the extraction of the *Biquadrate* or *Quadrato quadrate roote*, becauſe it may bee extracted by the rules formerly mentioned in the Extraction of the *Quadrate* or *Square roote* in chapter 17.

To extract the Biquadrate root.

XXIX. *The extraction of the Biquadrate roote is that, by which having a number given, we finde another number which being firſt multiplyed into it ſelfe, and then that Product multiplied into it ſelfe, produceth the number given*; So the Biquadrate roote of 16, is 2, which being

being multiplied into it ſelfe produceth 4, which being multiplied into it ſelfe produceth 16.

XXX. The Biquadrate roote of any Number commenſurable to its roote may be found in this manner, viz. *Extract the Square roote of the Number given, according to the Rules of the 17. chapter, then extract the Square roote of that roote firſt found, ſo will the latter roote bee the Biquadrate roote ſought.*

Thus if 20736 bee given, the *Biquadrate roote* thereof will bee found 12, *viz.* the ſquare roote of 20736 will bee found 144, and the ſquare roote of 144 will be found 12, which is the Biquadrate roote ſought; When the Number given is incommenſurable to its Biquadrate roote, annexe Quaternaries of Cyphers, *viz.* either 0000, 00000000, &c. and then proceede as before; ſo will you finde the roote neare, whoſe Fractionall part will be a Decimall.

Chap. XIX.

The Relation of Numbers in Quantitie.

I. *Thus farre single Arithmetique, comparative Arithmetique insues, which is wrought by Numbers, as they are considered to have Relation one to another.*

Boetius Arith. l. 1. cap. 21.

II. *This Relation consists in quantity, or quality.*

III. *Relation in quantity is the Reference or Respect, that the numbers themselves have one unto another:* As when the comparison is made betwixt 6 and 2, or 2 and 6: 5 and 3, or 3 and 5.

IV. *Here the Termes or Numbers propounded are alwayes two, whereof the first is called the Antecedent, and the other the Consequent:* So in the first example, 6 is the *Antecedent*, and 2 the *consequent*: and in the second, 2 is the *Antecedent*, and 6 the *consequent*.

V. *Relation in Quantity consists in the difference, or in the rate and reason that is found betwixt the Termes propounded.*

VI.

VI. *The difference of two Numbers is the Remainder, which is left after ſubtraction of the leſſe out of the greater:* So 6 and 2 being the Termes propounded, 4 is the difference betwixt them: for if you ſubtract 2 out of 6 the remainder is 4. Difference.

VII. *The rate or reaſon betwixt two numbers is the quotient of the Antecedent divided by the Conſequent*: So if it bee demanded what rate or reaſon 6 hath to 2, I anſwer, Triple reaſon: for if you divide 6 the Antecedent, by 2 the Conſequent, the quotient is 3, 2 being contained juſt 3 times in 6. In like manner is there triple reaſon betwixt 2 and 6, for if you divide 2 by 6, the quotient is $\frac{2}{6}$ or (which is all one) $\frac{1}{3}$ becauſe 6 being not once found in 2, there remains 2 for the Numerator, 6 the Diviſor being the Denominator of of the fraction given you in the Quotient, according to the 17. Rule of the 5. chapter aforegoing. Rate or Reaſon.

VIII. *This rate or reaſon of numbers is either equall or unequall.*

IX. *Equall reaſon is the Relation that equall numbers have unto one another*: As 5 to 5, 6 to 6, 7 to 7, &c. Equall Reaſon.

X. *Here the one being divided by the*

other, the quotient is alwayes an Vnite: for if it be demanded how often 5 is in 5, the answer is 1.

Unequall Reason.

XI. *Vnequall reason is the relation that unequall numbers have one unto another: and this is either of the greater to the lesse, or of the lesse to the greater.*

XII. *Vnequall reason of the greater to the lesse, is, when the greater Terme is Antecedent:* as of 6 to 2, 5 to 3, and the like.

XIII. *Here the quotient of the Antecedent divided by the Consequent is alwayes greater then an Vnite:* So 6 divided by 2, the Quotient is 3, and 5 divided by 3 the Quotient is $1\frac{2}{3}$.

XIV. *Vnequall reason of the lesse to the greater, is when the lesser Terme is Antecedent:* As of 2 to 6, 3 to 5, &c.

XV. *Here the quotient of the Antecedent divided by the consequent is alwayes lesse then an unite:* so 2 divided by 6, the Quotient is $\frac{2}{6}$ or $\frac{1}{3}$ and 3 divided by 5, the Quotient is $\frac{3}{5}$.

XVI. *Each of these kindes of unequall reason is againe subdivided into five other kindes or varieties, whereof the three first are simple, and the other two are mixt.*

XVII.

XVII. *The simple kindes of unequall reason are* 1. *Manifold.* 2. *Superparticular.* 3. *Superpartient.*

XVIII. *Manifold Reason of the greater to the lesse is, when the Consequent is contained in the Antecedent divers times without any part remaining*: As 4 to 2, 8 to 4, 16 to 8, which is called Double reason, because the lesse is contained twice in the greater; So 6 to 2 is triple reason, 8 to 2 fourefold reason, &c. Manifold Reason.

XIX. Here the quotient of the Antecedent divided by the Consequent is alwayes a whole number: So 8 divided by 2, the Quotient is 4.

XX. The opposite of this kinde, viz. *of the lesse to the greater, is called Submanifold*: Examples hereof are 2 to 4, 4 to 8, 8 to 16, &c. Likewise 2 to 6, 2 to 8, 2 to 10, &c. Submanifold.

XXI. Superparticular is, when the Antecedent containes the consequent once, and besides an aliquot part of the consequent; that is, an halfe, a third, a fourth, or a fifth part, &c. of the *consequent*, as 3 to 2, 4 to 3, 5 to 4 6 to 5, and the like; here 3 divided by 2, the *quotient* is $1\frac{1}{2}$ and 4 being divided by 3, the *quotient* is $1\frac{1}{3}$. In like manner 5 divided by 4, the *quotient* is Superparticular.

is 1 ¼ and 6 divided by 5 the *quotient* is 1⅕, wherefore I say 2, and halfe 2 (that is 1) constitute 3: So likewise 3 and one third part of 3 (*viz.* 1.) constitute 4, and so of the rest.

XXII. *Here the quotient of the Antecedent divided by the Consequent is a mixt number, whose whole part, as also the numerator of the fraction annexed, is always an unite*: as is observable in the example last mentioned.

Subsuperparticular.

XXIII. *The opposite reason of this kinde is Subsuperparticular*, as 2 to 3, 3 to 4, 4 to 5, 5 to 6, &c.

Superpartient.

XXIV. *Superpartient is when the antecedent contains the consequent once, and besides divers parts of the consequent*: As 5 to 3, 7 to 6, 7 to 4, 8 to 5, 9 to 5, 11 to 7, &c. here 5 divided by 3, the *quotient* is 1 ⅔ and therefore 5 containes 3 *once*, and ⅔ of 3; for 3 and *two thirds* of 3 (*viz.*) 2, constitute 5.

XXV. *Here the quotient of the Antecedent divided by the consequent is a mixt number, whose whole part being an unite hath always for the numerator of the fraction annexed unto it a number composed of one unites then one*: So the conference being made betwixt 5 and 3, and 5 the

An-

Antecedent being divided by 3 the Conſequent, the quotient is $1\frac{2}{3}$.

XXVI. *The oppoſite of this reaſon is Subſuperpartient* : Examples hereof are 3 to 5, 5 to 7, 4 to 7, 5 to 8, 5 to 9. 7 to 11, and the like. Subſuperpartient.

XXVII. *The mixt kindes of unequall reaſon are Manifold ſuperparticular, and manifold ſuperpartient.*

XXVIII. *Manifold ſuperparticular reaſon is when the Antecedent contains the conſequent divers times, and beſides an aliquot part of the conſequent* : As 5 to 2, 10 to 3, 17 to 4, 21 to 5, and the like. Manifold ſuperparticular.

XXIX. *Here the quotient of the antecedent divided by the conſequent is a mixt Number, whoſe whole part conſiſting of more unites then one, hath alwayes an unite for the Numerator of the Fraction annexed unto it* ; So 5 divided by 2, the Quotient is $2\frac{1}{2}$ and 21 divided by 5, the Quotient is $4\frac{1}{5}$.

XXX. *The oppoſite of this Reaſon is Submanifold Superparticular*; As 2 to 5, 2 to 7, 3 to 7, 4 to 9, &c. Submanifold ſuperparticular.

XXXI. *Manifold Superpartient is, when the antecedent containes the conſequent divers times, and beſides divers parts* Manifold ſuperpartient.

parts of the consequent; as 8 to 3, 17 to 5, 19 to 4, 28 to 5, &c.

XXXII. *Here the Quotient of the Antecedent divided by the Consequent is a mixt Number, whose whole part as also the Numerator of the Fraction annexed unto it, is alwayes a Number composed of moe unites then one:* So 8 divided by 3, the Quotient is $2\frac{2}{3}$ and 28 divided by 5, the Quotient is $5\frac{2}{5}$.

Submanifold superpartient.

XXXIII. *The Opposite here, is Submanifold Superpartient:* As 3 to 8, 5 to 17, 4 to 19, 5 to 28, and the like.

And these are the severall kindes or varieties of the Rates or Reasons that are found amongst Numbers, so that no two Numbers whatsoever can be named, but the Rate or Reason betwixt them is comprehended under one of these five kindes.

CHAP.

Chap. XX.

The Relation of Numbers in Qualitie, where; of Arithmeticall and Geometricall Proportion.

I. *Relation in quality (otherwiſe called Proportion) is the reference or reſpect that the Reaſons of Numbers have one unto another.* *Vide Euclid. l. 3. d. 1, & Alſted. Arith. c. 5.*

II. *Therefore here the Termes propounded ought alwayes to be moe then two,* for otherwiſe there cannot be a compariſon of Reaſons in the Plurall number.

III. *This proportion is either Arithmeticall, or Geometricall.*

IV. *Arithmetical proportion is, when divers numbers differ according to equall reaſon*; that is, have equall differences, as 2,4,6, 8, 10, &c. here 2 is the common reaſon, or difference betwixt 2 and 4, 4 and 6, 6 and 8, 8 and 10, &c. So 1,2,3,4, 5, 6, 7, &c. differ by *Arithmeticall* Proportion, 1 being the common reaſon or difference betwixt them. Arithmeticall Proportion.

V.

V. *Arithmeticall Proportion is either continued, or interrupted.*

1. Continued. VI. *Arithmeticall Proportion continued is, when divers Numbers are linked together by a continued progression of equal reason:* Such are the examples last propounded, as alſo theſe 1, 3, 5, 7, 9, 11, 13, &c. And 100000, 200000, 300000, 400000, &c.

VII. *In a ranke of numbers that differ by Arithmeticall Proportion continued, the ſumme of the firſt and laſt Termes being multiplied by halfe the Number of the Termes, the Product is the totall ſumme of all the Termes:* So it being demanded, how many ſtrokes the Clocke ſtrikes betwixt midnight and noone; the Termes of the Progreſſion in this queſtion are twelve, *viz.* 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. ſet in that order the Clocke ſtrikes, wherefore if I multiply 13 the ſumme of 12 and 1 (the firſt and laſt Termes) by 6 (being halfe the number of the Termes) the Product is 78, which is the totall ſumme of all the Termes propounded being added together.

VIII. *Or thus, Multiply the number of the Termes by the halfe ſumme of the firſt and laſt Termes, and then likewiſe the*

Pro-

Product will give you the totall of all the Termes: ſo 13, 11, 9, 7, 5, 3. being given, their totall is 48, for 8 the halfe ſumme of 13 and 3, the firſt and laſt Termes being multiplied by 6, the number of the Termes, the Product is 48.

IX. *Three numbers being given, that differ by Arithmeticall proportion continued, the meane being doubled, is equall to the ſumme of the extreames*: So 5, 6, 7 being given, 6, being doubled is equall to the ſumme of 5 and 7 the two extreames.

X. *Arithmeticall Proportion may bee continued either upwards or downwards.*

XI. *Upwards, when the Termes of the Progreſſion increaſe*, as theſe, 2, 4, 6, 8, 10, 12, &c. or theſe 1, 2, 3, 4, 5, 6, &c. And this laſt ranke is more particularly termed *Naturall Progreſſion*. Upwards.

XII. *Here when the firſt Terme is alſo the common difference of the Termes, the laſt Terme being divided by the number of the Termes, the quotient will give you the firſt Terme of the ranke: again in this caſe the firſt Terme multiplied by the number of the Termes produceth the laſt Terme*: So this ranke 3, 6, 9, 12, 15, 18, 21, being propounded, wherein 3 is both the firſt Terme

Terme as also the common difference of the Termes: I say 21 the last Terme being divided by 7 the Number of the Termes, the Quotient is 3 the first Terme; Contrariwise 3 the first Terme multiplied by 7, produceth 21, the last Terme.

Downwards

XIII. *Arithmeticall Proportion continued downwards is, when the Termes of the progression decrease:* Such as are 35,32, 29,26,23,20: And 40,35,30, 25,20,15, 10,5.

This Rule is the inverse of the 12 Rule aforegoing.

XIV. *Here when the last Terme is also the common difference of the Termes, the first Terme being divided by the Number of the Termes, the quotient will give you the last Terme: Againe, the last Terme multiplied by the Number of the Termes, produceth the first Terme of the ranke.*

For example, this ranke 40,35, 30,25, 20,15,10, 5 being propounded, in which 5 is both the last Terme, and likewise the common difference of the Termes: I say, 40 the first Terme being divided by 8 the number of the Termes, the quotient is 5 the last Terme: on the other side 5 the last Terme being multiplied by 8, the Product is 40 the first Terme.

2. Interrupted.

XV. *Arithmeticall Proportion interrupted is when the progression is discontinued:*

nued: as in theſe numbers 2, 4. 8, 10; Here 2 and 4 being compared with 8 and 10 differ according to *Arithmeticall* proportion, but ſo doe not 4 and 8 differ, for 2 is the *common difference* betwixt 2 and 4, 8 and 10, whereas the *Difference* betwixt 4 and 8 is 4. In like manner 8, 14, 17, 23, differ by *Arithmeticall* Proportion *interrupted.*

XVI. *Foure numbers being given, that differ by Arithmeticall Proportion either continued or interrupted, the ſumme of the two meanes is equall to the ſumme of the two extremes:* So 5, 6, 7, 8, being given, the ſumme of 6 and 7, the two *mean* numbers is equall to the ſumme of 5 and 8, the two extremes: And 8, 14 17, and 23, being propounded, the ſumme of 14 and 17 being added together is equall to the ſumme of 8 and 23.

XVII. *Geometricall Proportion is, when divers numbers differ according to like reaſon:* that is, when their *differences* are reaſons of the ſame kinde; ſo 1, 2, 4, 8, 16, 32, &c. which differ one from another by double reaſon, are ſaid to differ by *Geometricall* Proportion, for as 1 is halfe 2, ſo 2 is halfe 4, 4 halfe 8, 8 halfe 16, 16 halfe 32, &c. Geometricall proportion.

XVIII. *Geometricall Proportion is either continued or interrupted.*

1. Continued.

XIX. *Geometricall Proportion continued is, when divers numbers are linked together by a continued progression of the like reason:* Of this sort is the example last given: for as 1 is to 2, so is 2 to 4, 4 to 8, 8 to 16, 16 to 32, &c. So likewise the numbers 3, 9, 27, 81, 243, 729, &c. differ by *Geometricall* Proportion continued, *viz.* by triple reason, each of them being contained three times in the next number that followes it.

XX. *In Numbers continually proportionall from* 1, *the first number from* 1, *is the roote or first power, the second is the square or second power, the third the Cube or third power, the fourth the biquadrat or fourth power, the fifth the fifth power, the sixth the sixth power, &c.* So in this ranke of numbers, 1, 3, 9, 27, 81, 243, 729, &c. 3 is the roote, 9 the square, 27 the cube, 81 the biquadrat, 243 the fifth power, 729 the sixth power, &c.

Mean Proportionals.

XXI. *The roote being multiplied by it selfe produceth the square, which being again multiplied by the roote produceth the cube, and so each proportionall being multiplied by the roote produceth the proportionall*

nall next above it, and then the numbers comprehended betwixt 1, *and the laſt number produced are called meane Proportionalls*: So in this ranke of proportionall numbers, 1, 2, 4, 8, 16, 32, &c. 2 the roote being multiplied by it ſelfe produceth 4 the ſquare, which being againe multiplied by 2, produceth 8 the cube, then 8 being multiplied by 2, the Product is 16 the biquadrat, and ſo of the reſt in their order, and here 2, 4, 8, and 16 are the meane proportionalls in the ranke propounded.

XXII. *If you multiply the roote by it ſelfe, and conſequently the ſubſequent numbers by themſelves, the numbers intercepted betwixt* 1 *and the number laſt produced may not unfitly bee called continuall means*: So 2 being given for the roote, and multiplied by it ſelfe, the product is 4, which being again multiplied by it ſelfe produceth 16, then 16 in like manner ſquared, produceth 256, which likewiſe multiplied by it ſelfe produceth 65536, I ſay then that 2, 4, 16, and 256 are continuall means betwixt 1, and 65536. Continuall means. *Briggius Arith. Log. cap.* 6.

XXIII. *The continuall means comprehended betwixt any number given, and* 1, *are diſcovered by a continued extraction of the ſquare rootes*; for example 65536

being given, the roote thereof extracted is 256, whose roote is 16, then the roote of 16 is 4, and the roote of 4 is 2; so that at last I finde 256, 16, 4, and 2 to be continuall means intercepted betwixt 65536 and 1, as before.

XXIV. *In numbers that increase by Geometricall proportion continued, If you multiply the last Terme by the quotient of any one of the Termes divided by another Terme, which being lesse is next unto it, and then deducting the first Terme out of that Product, divide the remainder by a number that is an unite lesse then the quotient, the last quotient will give you the totall of all the Termes propounded in the progression*; So this ranke 2, 6, 18, 54, 162, 486, 1458, being propounded, wherein the proportionalls differ by subtriple proportion, I first take 2 and 6 the two first Termes, and dividing 6 by 2, I finde the quotient 3, wherefore multiplying 1458 the last Terme, by 3 the quotient, the Product is 4374, out of which I deduct 2 the first Terme, the remainder is 4372, which being divided by 2 (viz. a number which is an unite lesse then 3 the quotient) the last quotient gives me 2186, which is the totall summe of the proportionalls propounded.

XXV.

XXV. *Three proportionalls being given, the ſquare of the meane is equall to the product of the extremes*: So 4,8, and 16 being propounded, 8 times 8 being 64, is equall to 4 times 16, which is likewiſe 64.

XXVI. *Geometricall proportion interrupted is, when the progreſſion of like reaſon is diſcontinued*; In ſuch ſort that foure numbers being given, the like reaſon is not found betwixt the ſecond and third, that is betwixt the firſt and ſecond, and the third, and fourth: Of this ſort are theſe numbers 2,4,16,32. here as 2 is to 4, ſo is 16 to 32, for they differ by double reaſon; but as 2 is to 4, ſo is not 4 to 16, for 4 and 16 differ by fourefold reaſon, 4 being contained foure times in 16: So likewiſe 4, 8, 8, 16, differ according to Geometricall proportion interrupted. 2. Interrupted.

XXVII. *The numbers of Multiplication and Diviſion are proportionall*; For in Multiplication as 1 is to the Multiplicator, ſo is the Multiplicand to the Product, or as 1 is to the Multiplicand, ſo is the Multiplicator to the Product: Againe, in Diviſion as the Diviſor is to 1, ſo is the Dividend to the Quotient: or as the Diviſor is to the Dividend, ſo is 1 to the Quotient.

XXVIII. *Foure proportionall Numbers whatsoever being given, the Product of the two means is equall to the Product of the two extremes:* So 2,4,16, 32. being propounded, 4 times 16 (which is 64) is equall to 2 times 32, which is likewise 64.

Chap. XXI.

The Rule of Three direct.

I. From the last Rule of the Chapter aforegoing ariseth that precious Gemme in Arithmetique for the excellency thereof called the Golden Rule.

II. The Golden Rule is that by which certain Numbers being given, another number Geometrically proportionall unto them may be found out.

III. The Golden Rule is either single or compound.

The Rule of Three.

IV. *The single Rule is, when three Termes or Numbers are propounded, and a fourth proportionall unto them is demanded: from whence it is likewise called* the Rule of Three.

V. *The*

V. *The Termes of the Rule of Three consist of two Denominations*, viz. *two of the termes propounded have one, and the other terme given with the terme required have another*: So this question being demanded, If foure Students spend nineteen pounds in certain moneths, how much will serve eight Students for the same time? the *Answer* will be 38 L. and here Students and Pounds are the two Denominations of the Terms in the question, whereof 4 and 8 (being two of the termes propounded) have the Denomination of Students. And 19 the other terme given together with 38 the terme required have the Denomination of Pounds. The divers Denominations of the Termes thereof.

VI. *In the rule of Three the numbers given must be so ranked, that the knowne number or terme upon which the question is moved, must possesse the third place in the rule, also that of the other two which is of the same Denomination with the third, must be in the first place, and consequently the other known terme which is of the same Denomination with the fourth terme required, (or answere of the question) must possesse the second place*: So in the question before mentioned, the termes 4, 19 and 8 are thus placed, *viz.* 8 is the terme upon The right ordering of the Termes.

which the queſtion is moved, and therefore to poſſeſſe the third place in the Rule, 4 is of the ſame Denomination with 8, *viz.* of Students, and therefore to be in the firſt place. Laſtly, 19 being of the ſame Denomination with the terme ſought, *viz.* of money, is to be in the ſecond place, and ſo they will bee placed in the rule *thus*:

ſtud.	*pounds*	*ſtud.*
As 4 — is to —	19 — ſo is —	8 — to —

And here, for the better diſcerning of the terme upon which the queſtion is moved, you may obſerve, that for the moſt part it is the knowne number in the queſtion which immediately followeth theſe or ſuch like words, *viz.* How many? How much? What will? How long? How farre? *&c.*

Another example may be this, If certain buſhels of Provender ſerve 8 horſes 12 dayes, how many dayes will the ſame provender laſt 16 horſes? This queſtion being thus propounded, the termes thereof will ranke themſelves, as followeth.

horſ.	*da.*	*horſ.*
8	12	16

VII.

VII. *The Rule of Three is either direct, or inverse.*

VIII. *The Rule of Three direct is, when the terme required ought to proceed from the second terme, according to the same rate and proportion that the third proceeds from the first:* So in the first example of the sixth rule aforegoing, as 8 the third terme differs from 4 the first by double reason, so ought the terme required to differ from 19 the second terme; that is, as 8 is double 4, so ought the terme required to be double 19; for if 19 pounds bee required to maintain foure Students three moneths, as much more must needs bee requisite for the maintenance of 8 Students the same time; and therefore in this Case you may say in a direct proportion, as 4 is to 8, so is 19 to a number, which ought to be as great again as 19. The Rule of Three direct.

IX. *In the direct Rule of Three if you multiply the second terme by the third, or (which is all one) the third terme by the second, and then divide the Product by the first, the quotient will give the fourth term, or fourth proportionall required:* So in the question before propounded if you multiply 19 by 8, the Product is 152, which if you divide by 4, the Quotient will give you

How to worke the same Rule. viz. 1. In whole Numbers, the Termes being single Numbers.

you 38, the fourth Terme demanded, and then the whole work will ſtand thus:

4 ——— 19 ——— 8 ——— (38

8

4) 152 (38

12

32

32

0

The ſecond example may be this, If 37 yards of Linnen cloth coſt 9 pounds, what is the price of a yard, at that rate? the anſwer will be $\frac{2}{37}$ l. or 4. ſh. 10. $\frac{14}{37}$ d. *viz.* 9 multiplyed by 1, is 9 for the Dividend, which being leſſe then the Diviſor 37, the Quotient will be found $\frac{2}{37}$ l. (by the 17th. rule of the 5th. Chapter.) Laſtly, $\frac{2}{37}$ l. will be reduced into 4. ſh. 10. $\frac{14}{37}$ d. by the 8th. rule of the 7th. Chapter.

yards, *l.* *yard.*

37 — 9 ——— 1 — ($\frac{2}{37}$ lb.

2. In whole Numbers, the Termes being compound.

The third example may be this queſtion, If a wedge of Gold waighing 19 Ounces, 3 penny waight and 5 Graines, bee worth 62 l.

62 l. 10. ſh. 6. d. What is the value of an Ounce of the ſame Gold? the anſwer will be found 3 l. 5. ſh. 3 $\frac{1622}{9197}$ d. And here obſerve that when either of the three known termes in the rule is *compounded* of numbers under *divers Denominations*, ſuch terme muſt bee reduced into the leaſt of theſe Denominations (by the third rule of the ſixth Chapter.) Alſo when the firſt and third termes are not of the ſame particular Denomination; *viz.* If one of them be Ounces and the other Graines, or one of them Moneths, and the other Houres, *&c.* they are to bee reduced, into the leaſt of thoſe Denominations (by the ſecond rule of the ſixth Chapter;) So in this example, the three termes being reduced will ſtand in the rule thus:

	graines	*pence*	*graines.*
If	9197	15006	480

Laſtly, proceeding according to the 9. rule of this Chapter, the *anſwer* will bee found 783 $\frac{1622}{9197}$ d. which being reduced according to the 8. rule of the 7. chapter, will be 3. l. 5. s. 3 $\frac{1622}{9197}$ d.

The fourth example may bee this; If $\frac{1}{8}$ of a yard of Pluſh bee worth $\frac{2}{3}$ of a pound ſterling, 3. In Fractions.

sterling, what is the value of $\frac{1}{16}$ of a yard of the same Plush? The *answer* will bee found $\frac{16}{240}$ li. or 1. s. 4. d. For if you proceed according to the ninth rule of this Chapter, with respect unto Multiplication and Division in Fractions explained in the tenth and eleventh chapters, the *answer* will be found $\frac{16}{240}$ l. Or (which is the same in effect) *Multiply the Denominator of the first Terme, and the Numerators of the second and third termes continually, so is the last Product a new Numerator: Also multiply the Numerator of the first terme, and the Denominators of the second and third termes continually, so is the last Product a new Denominator, which new Fraction is the fourth terme sought:* So in the said example multiplying the Denominator 8, and the Numerators 2 and 1 continually, the Product will bee 16 for a new Numerator; Also multiplyiug the Numerator 5, with the Denominators 3 and 16 continually, the product is 240 for a new Denominator; so is the *answer* of the question found to be $\frac{16}{240}$ l. which being reduced according to the 8. rule of the 7. chapter, will be 1. s. 4. d.

See continuall Multiplication in the last Rule of the 4. Chapter.

y. l. y.
$\frac{5}{8}$ —— $\frac{2}{3}$ —— $\frac{1}{16}$ — ($\frac{16}{240}$ lb.

The

The fifth example may bee this, If a quantity of Amber greece waighing 1 $\frac{1}{7}$ lb. Troy be worth 60 pounds ſterling, what is the value of 19 $\frac{1}{8}$ graines? The *anſwer* will bee found 2. s. 4 $\frac{112}{192}$ d. Here you are to obſerve, that in the rule of three in *Fractions*, when either of the termes is a whole number or a mixt number, ſuch whole number or mixt number is to be reduced into an improper Fraction by the ninth or tenth rule of the ſeventh chapter: Alſo when the firſt and third termes are not of the ſame particular Denomination; ſuch of the ſaid termes which is of the leſſer Denomination, is to bee reduced into the greater Denomination by the 15. rule of the 7. chapter, and then the operation will be as before: ſo the termes of this *queſtion* being firſt of all reduced into improper Fractions, will ſtand in the rule thus: 4. In mixt Numbers.

$\frac{12}{7}$ lb. —— $\frac{60}{1}$ l. — $\frac{117}{8}$ gr.

And ſince the third terme $\frac{117}{8}$ gr. is not of the ſame Denomination with the firſt, it muſt be reduced into ſuch Denomination, *viz.* $\frac{117}{8}$ gr. is $\frac{117}{8}$. of $\frac{1}{24}$ of $\frac{1}{20}$ of $\frac{1}{12}$ of a pound Troy, which compound Fraction (by the fifteenth rule of the ſeaventh chapter,

ter,) will be reduced into the single Fraction $\frac{157}{46080}$ of a pound Troy, and so the termes will stand in the rule thus:

$$_{7}\text{ lb.} \text{———} \frac{60}{1}\text{ l.} \text{———} \frac{157}{46080}\text{ lb.}$$

Then working as in the fourth example, the *answer* will be found $\frac{65940}{552960}$ l. which being reduced by the eighth & third rules of the seventh chapter is 2. s. 4 $\frac{119}{192}$ d.

5. In Decimals. The rule of three in *Decimals* may bee exemplified by the *question* mentioned in the third *example* which is here repeated, *viz.* If 19 Ounces, 3 penny waight and 5 graines of Gold, be worth 62. l. 10. s. 6. d. what is the value of an Ounce? The *answer* will bee found 3. l. 5. s. 3. d. *fere.* viz. the termes being reduced into *Decimals* by the *Table of Reduction* in page 87 according to the 15. and 16. rules of the 12. chapter, will stand in the rule thus:

lb. *Troy*	l. *sterl.*	lb. *Troy.*
1.596701 —	62.525 —	.083333

Lastly, proceeding according to the 9. rule of this chapter, with respect unto Multiplication and Division in *Decimalls* explained in the fifteenth and sixteenth Chapters,

Chapters, the *answer* will bee found 3,263, *&c.* that is, 3.l. 5.s. 3.d. *ferè*, as will appeare by reducing the *Decimall* ,263 according to the eighteenth or nineteenth rule of the twelfth Chapter.

X. *For the proofe of the direct rule of Three, multiply the fourth terme by the first, which done, if that Product be equall to the Product of the second and third Termes, the worke is right, otherwise it is erroneous*: So in the first *Example*, 38 being multiplyed by 4, the Product is 152, which is also the Product of 19 multiplyed by 8 as apppears by the *Example*. In like manner in the fourth *Example* $\frac{5}{8}$ (the first terme) being multiplyed by $\frac{36}{240}$ (the fourth terme) · the Product will bee $\frac{180}{1920}$ which reduced according to the third Rule of the seventh Chapter is $\frac{3}{32}$, which is equall unto the Product of $\frac{1}{3}$ and $\frac{1}{16}$ the second and third termes, as appears by the worke. The proof.

CHAP.

Chap. XXII.

The Inverſe Rule of Three.

I. *The Rule of Three Inverſe is, when the Terme required ought to proceed from the ſecond terme according to the ſame rate or proportion, that the firſt proceeds from the third.* So in the laſt example of the 6 Rule of the 21. Chapter aforegoing. As 8 is halfe 16, ſo ought the terme required to be half 12, for if certain buſhels of provender ſerve 8 horſes 12 dayes, 16 horſes will eat up as much provender in half that time; And therefore you cannot ſay here in a direct proportion (as before in the rule of *Three direct*) as 8 to 16, ſo is 12 to another Number, which ought to bee in that caſe as great again as 12. but contrariwiſe by an inverted proportion, beginning with the laſt terme firſt; as 16 is to 8, ſo is 12 to another number, which ought to be in this caſe halfe 12. And by the due obſervation of this definition together with that of the Rule of *Three direct* (propounded in the 8 Rule of the 21 Chapter)

Chapter) when any question discoverable by the *single Rule of Three* is propounded, you may readily discern by which of those rules it ought to bee resolved: for if the three termes given looke for a fourth in a *direct* proportion as they stand ranked in the rule, you must resolve the question by the *direct Rule*, contrariwise when the proportion is inverted or turned backwards; it ought to be resolved by the *Inverse rule of Three*.

How to worke the Rule of Three Inverse.

II. *In the Inverse rule of Three if you multiply the first terme by the second, or (which is all one) the second by the first, and then divide the Product by the third, the quotient will yeeld you the fourth terme required:* So in the question premised in the last rule, if you multiply 12 by 8 the Product is 96, which if you divide by 16, the Quotient gives you 6, the fourth terme required.

```
8 ——— 12 ——— 16 ——— 6
        8
    ------
16) 96 (6
    96
    ---
     0
```

By this last mentioned Rule it is evident,

To discerne whether a question in the Rule of Three belong to the Rule direct, or Rule inverse.

that in the *rule* of three inverse, the third terme is the *Divisor*, and by the 9. rule of the 21. Chapter, it is also manifest that in the *rule* of three *direct* the first terme is the *Divisor*: Now for a further help to discover whether a question belong to the *rule direct* or *rule inverse*, observe alwaies by the tenour of the question whether more bee required or lesse; *viz.* Whether the terme sought must be greater then the middle terme or lesser, for when more is required, the lesser of the two extreme numbers is the *Divisor*, but when lesse is required, the greater extreme is the *Divisor*.

Lastly, the *Divisor* being knowne, it will bee apparent by what is before said whether it bee a *rule direct* or *rule inverse*.

Againe, take this for another *Example*; If 108 *Pioners* performe a piece of worke in 56 houres, in what time will 83 *Pioners* performe so much work?

108

108 — 56 — 83 — 72 $\frac{22}{83}$

56

648

549

83) 6048 (72 $\frac{22}{83}$

581

238

166

72

So that 83 men are able to do as much worke in 72 houres, and $\frac{22}{83}$ of an houre, as 108 men can doe in 56 houres, which is the resolution of the *Question* propounded.

Another example: If 3 $\frac{1}{4}$ yards in length, of cloth which is 1 $\frac{1}{2}$ yards in breadth, will make 2 Cloakes, how much stuffe which is $\frac{1}{2}$ of a yard in breadth, will serve to a lining for the said Cloake? *Facit* 9 $\frac{3}{4}$ yards. Worke according to the second rule of this Chapter, with respect unto Multiplication and Division in Fractions explained in the tenth and eleventh Chapters: Or which is the same (after the mixt numbers reduced into Fractions.)

Rule of Three inverse in Fractions.

Multiply the Denominator of the third terme and the Numerators of the first and second termes continually, so is the Product a new Numerator: Again, multiply the Numerator of the third terme, and the Denominators of the first and second termes continually, so is the Product a new Denominator, which new Fraction is the answer of the question.

breadth *length* *breadth.*

$1\frac{1}{4}$ *y.* —— $3\frac{1}{2}$ *y.* —— $\frac{1}{8}$

$\frac{7}{4}$ —— $\frac{7}{2}$ —— $\frac{1}{8}$

Facit $\frac{122}{40}$ *yards,* or $9\frac{4}{5}$ *yards.*

III. *In the Inverse rule of three, the Product of the third terme multiplied by the fourth, must accord with the Product of the first and second termes, otherwise the worke is erroneous*: So in the first example of the last rule the Product of 16 multiplyed by 6, is 96, which likewise is the product of 12 multiplied by 8.

If any bee desirous to exemplifie the rules in the subsequent Chapters by *Fractions* or *mixt Numbers*, he may do it by observing the 4. and 5. examples of the last chapter, and the last example of this chap.

CHAP.

CHAP. XXIII.

The double Golden Rule direct, performed by two ſingle Rules.

I. *THe Compound Golden Rule is, when more then three termes are propounded.*

II. *Vnder the Compound Golden Rule is comprehended the double Golden Rule, and divers Rules of plurall proportion.*

III. *The double Golden Rule is, when five termes being propounded, a ſixth proportionall unto them is demanded:* as in this queſtion, If 4 Students ſpend 19 pounds in 3 moneths, how much will ſerve 8 Students 9 moneths? Or this, If 9 buſhels of provender ſerve 8 horſes 12 daies, how many dayes will 24 Buſhels laſt 16 horſes? The double Golden Rule.

IV. *The five termes given in this rule conſiſt of two parts,* viz. *a ſuppoſition expreſſed in the three firſt termes; and a demand, propounded in the two laſt:* So in the firſt example of the laſt rule, this clauſe (if 4 Students ſpend 19 pounds in 3 The parts into which the termes of the ſame rule are diſtributed.

moneths) is the ſuppoſition, and this (how much will ſerve 8 Students 9 moneths) is the demand: likewiſe in the other example of the ſame rule, this clauſe (if 9 buſhels of provender ſerve 8 horſes 12. dayes) is the ſuppoſition, and this (how long or how many dayes will 24 buſhels laſt 16 horſes) is the demand propounded.

The right ordering of the termes.

V. *Here for ranking the termes propounded in their due order, firſt obſerve amongſt the termes of ſuppoſition, which of them hath the ſame Denomination with the terme required, then reſerving that terme for the ſecond place write the other two termes of ſuppoſition one above another in the firſt place, and laſtly the terms of demand likewiſe one above another in the third place of the rule, in ſuch ſort that the uppermoſt may have the ſame Denumination with the uppermoſt of thoſe in the firſt place:* Example. If 4 Students ſpend 19 pounds in 3 moneths, how much will ſerve 8 Students 9 moneths? Here the three termes of ſuppoſition are 4, 19, and 3, and of theſe termes 19 hath the ſame *Denomination* with the terme required, *viz.* of pounds (for you are to inquire how much money is requiſite for the maintenance of 8 Students 9 moneths:) wherefore reſerving

serving 19 for the second place I write 4, and 3 one above another thus; then drawing a line upon the right hand of 4 I write 19 in the second place; this done, the worke will stand as in the *Margent*: Last of all the termes of Demand being 8 & 9, and having the *Denomination* of Students I place it in the same line with 4 and 19, and write 9 under it; all this performed the termes in this *question* ranke themselves as followeth:

4	19	8
3		9

Margent:

4	19
3	

viz. *thus*,

4	19	8
3		9

Or thus,

3	19	9
4		8

In like manner if the second *question* of the third Rule of this Chapter were propounded, the Termes thereof ought to be disposed,

Thus,

18	12	16
9		24

Or thus,

9 — 12 — 24

8 — 16

VI. *Questions discoverable by the double Golden Rule may bee resolved by two single Rules of Three, or by the Golden Rule Compound of five Numbers.*

The proportions of the double Golden Rule when it is performed by two single Rules.

VII. *When questions of this nature are resolved by two single rules, the proportions are as followeth:*

I. *As the uppermost terme of the first place, is to the middle terme; So is the uppermost terme of the last place to a fourth Number.*

II. *As the lower terme of the first place is to that fourth Number; So is the lower terme of the last place to the terme required.*

So in this example before recited, using the lower terme of the first place as a common number in the first proportion, say *thus*, 4 — 19 — 8 / 3 — 9

I. If in three moneths 4 Students spend 19 pounds, what will serve 8 Students the same time?

Or

Or thus, If foure Students ſpend nineteene pounds, what will eight ſpend?

Or thus, As 4 to 19, ſo 8 to another number.

And then the fourth proportionall anſwerable to 4, 19, and 8, the three Numbers given in this proportion, is 38 (by the ninth Rule of the one and twentieth Chapter aforegoing.) Again, to finde the terme required uſing the uppermoſt terme of the third place as a common Number in this laſt proportion, *ſay as followeth*:

II. If in 3 moneths 8 Students ſpend 38 pounds, how much will ſerve them for 9 moneths?

Or thus, If 3 give 38, what will 9 yeeld you?

Or thus, As 3 to 38, ſo 9 to the *terme required*.

Which you ſhall likewiſe finde (by the ninth Rule of the one and twentieth Chapter before cited) to bee 114. for 38 being multiplyed by 9 the Product is 342, which divided by 3 yeeld you in the quotient 114. So that *I conclude*, if foure Students ſpend nineteen pounds in three moneths, 114 pounds will ſerve 8 Students

dents 9 moneths; as you may further observe by the worke following:

4—19—8 3 9—114

4—19—8—38 3—38—9—114

8 9

4) 152 (38 3) 342 (114

12 3

32 04

32 3

0 12

12

0

VIII. *The double Golden Rule is either direct or inverse.*

The double Golden Rule direct.

IX. *The direct Rule is, when both the single rules doe each of them looke for a fourth terme in a direct proportion:* As in the *example* of the 7. rule, for there the *first proportion* being this, if in 3 moneths 4 Students spend 19 pound, what will serve 8 Students the same time? here it is evident by the eighth rule of the one and twentieth chapter, that 4. 19, and

and 8, the three termes given, looke for a fourth in a *direct proportion*: And in the *last proportion* being this, if in 3 moneths 3 Students spend 38 pound, how much will serve them for 9 moneths? It is as manifest, that a fourth is likewise expected in a *direct proportion*: for if 8 Students in 3 moneths spend 38 pounds, they will spend in 9 moneths three times so much, and therefore here you may say in a *direct proportion*, as 3 the first terme is to 9 the third, so is 38 the second to a fourth Number which ought to be in this case three times so great as 38, because 9 is three times as great as 3, according to the eighth rule of the one and twentieth chapter before cited; Wherefore I *conclude* that this question (if 4 Students in three moneths spend 19 pound, how much will serve 8 Students 9 moneths?) ought to be performed by the *double Golden Rule direct*, as above in the 7 rule of this chapter.

For another *Example* take this, If the carriage of 7, C. waight 128 miles, costs 48 shillings, for how much may I have 3, C. waight carried 32 miles after the same rate? The termes of this question according to the 5 rule of this chapter rank themselves in *this order*. 128

128 —— 48 —— 32

7 3

Now to discover whether this question ought to bee resolved by the *double Rule direct*, or no, taking the lower terme of the first place, I *say*.

I. If the carriage of 7, C. 128 miles, cost 48, s. what will the carriage of 7, C. 32 miles cost?

This done, I see plainly that the *fourth terme* here expected proceeds from the other three in a *direct proportion*, for that number must needs happen to bee by the same rate and *proportion* lesse then 48, that 32 is lesse then 128: wherefore finding that fourth number by the ninth rule of the one and twentieth Chapter to be 12, s. I proceed to the second proportion, and say:

II. If the carriage of 7, C. 32 miles costs 12, s. how much must I give to have 3, C. carried the same distance?

And here likewise finding a *fourth number* to bee looked for in a *direct* proportion, I discover that fourth by the said ninth rule of the one and twentieth Chapter

er to be $5\frac{1}{7}$ s. which is the *terme demand-*
ed, and the anſwer to the queſtion pro-
pounded: So that at laſt *I conclude*, If the
arriage of 7, C. 128, miles coſt, 48, s. the
arriage of 3, C. 32, miles will coſt mee
$5\frac{1}{7}$ s. according to the ſame rate: See the
hole work.

128 —— 48 —— 32
7 —— 3 —— $5\frac{1}{7}$

128 —— 48 —— 32 —— 12
32
96
144
128) 1536 (12
128
256
256
0

7 —— 12 —— 3 —— $5\frac{1}{7}$
3
7) 36 (5
35
1

CHAP.

Chap. XXIV.

The Double Golden Rule Inverse, performed by two single Rules.

The double Golden Rule Inverse.

The Double Golden Rule Inverse is, when one of the single Rules looke for a fourth Terme in an Inverted proportion. As in the last example propounded in the fifth rule of the last Chapter. For there if you ranke the termes of that question, *thus,*

8 —— 12 —— 16
9 —— 24

You shall finde the termes of the first proportion to looke for a fourth number in an inverted proportion: For if 9 bushels of provender serve 8 Horses 12 dayes, 16 Horses will eat up so much provender in halfe that time; But if you order the Termes *thus,*

9 —— 12 —— 24
8 —— 16

You

You ſhall perceive the termes of the firſt proportion to expect a fourth in an *inverted* proportion, which will bee likewiſe the terme demanded; for then *I ſay*:

I. If 9 buſhels of provender laſt 8 Horſes 12 dayes, how long or how many dayes will 24 Buſhels ſerve the ſame number of Horſes?

And here the termes propounded looke for a fourth in a *direct* proportion, which I finde by the ſingle Rule of *Three direct* to be 32. That fourth number being ſo found, *I ſay* again,

II. If 24 Buſhels of provender, ſerve 8 Horſes 32 dayes, how long will 24 Buſhels laſt 16 Horſes?

And here the fourth terme expected proceeds from the other three in an *inverted* proportion; for if 24 Buſhels of provender ſerve 8 Horſes 32 dayes, 24 Buſhels will laſt 16 Horſes a leſſe time: wherefore howſoever you ranke the termes of this queſtion, the proportions thereof being ſevered into two ſingle Rules, you ſhall finde one of them alwayes *inverted*, and therefore the fourth term thereof alwayes diſcoverable by the ſingle rule of

Three

Three *inverse* : whereupon I conclude, that the ſame queſtion being given, it ought to be reſolved by the double Rule *Inverſe*, and not by the double Rule *direct*, as thoſe propounded in the laſt Rule of the former Chapter.

Now the Reſolution of this queſtion being ranked after the firſt manner is, *as followeth* :

8——12——16
9 24——16

8——12——16——6
8
16) 96 (6
96
0

9——6——24
6
9) 144 (16
9
54
54
0

Again

Again the resolution of the same *question*, being ranked after the last manner *is this*,

9 —— 12 —— 24
8 —— 16 —— 16

9 —— 12 —— 24 —— 32
12
48
24
9) 288 32
27
18
18
0

8 —— 32 —— 16 —— 16
8
16) 256 (16
16
96
96
0

So that at last *I say*, If 9 bushels of provender serve 8 horses 12 dayes, 24

bushels will last 16 horses 16 dayes, which is the resolution of the *question* propounded.

The substance of that which hath been delivered in this and the preceding *Chapter*, concerning the *double Rule of Three*, may be expressed as in the following *Rule, viz.*

Let the first single Rule consist of any three of the 5 numbers given, which will stand in Rule according to sense and reason, then (according to the latter part of the 2. Rule of the 22 Chapter) observe whether it be a Rule Direct or Inverse, and multiply accordingly; that done, place the Dividend for a Numerator, and the Divisor for a Denominator, so is such fraction (whether proper or improper) the answer of the first single rule; lastly, the said fraction, (or answer of the first rule) together with the other two termes in the question, which were not mentioned in the first single rule, must make the second single rule, which 3 termes, reason, together with the directions in the 6 rule of the 21 Chapter will shew how to order, then observing whether it be a rule direct or inverse, work it accordingly as a rule of 3 in fractions, so will the answer there-

of

of be the answer of the question propounded.

Example. If I pay 28 *shillings* for the carriage of 3 *hundred weight* for 50 *miles*, how much ought I to pay for the carriage of 17 *hundred weight* for 84 *miles*, at the same rate? *Facit.* 13 l. 6 s. $6\frac{12}{25}$ d.

	C.	Sh.	C.	
I. If	3	—— 28	—— 17	*Rule direct.*
			28	
			136	
			34	
	Facit		476	*Shillings.*
			3	

II. If $\frac{10}{1}$ *Miles* — $\frac{476}{3}$ *sh.* — $\frac{84}{1}$ *miles*,
Facit $\frac{12284}{150}$ *sh.* or 13 l. 6 s. $6\frac{12}{25}$ d.

Another way of resolution of the former question, by changing the termes in the first *single rule* may be thus.

	Miles	C.	Miles	
I.	50	—— 3	—— 84	*Rule Inverse.*
	3			

Facit $\frac{150}{84}$ *hundred waight.*

II. $\frac{150}{84}$ C. — $\frac{22}{1}$ ſh. — $\frac{17}{1}$ C. *Rule direct.*

Facit as before $\frac{12284}{150}$ Shillings.

Another way, by changing the termes of the firſt *ſingle rule.*

C. M. C.

I. If 3 —— 50 —— 17 *Rule Inverſe.*

3

Facit $\frac{150}{17}$ *Miles.*

II. If $\frac{150}{17}$ m. — $\frac{22}{1}$ ſh. — $\frac{22}{1}$ m. *Rule direct.*

Facit as before $\frac{12284}{150}$ *Shillings.*

Thus you ſee that the firſt *ſingle rule* may be varied three manner of wayes, one of which will alwayes be obvious, ſo that working as before, you will finde the anſwer of any queſtion reſolvable by the *double rule* of *Three*, or *Golden rule compound* of 5 numbers, with as much expedition, and as little charge to the memory, as by any other way.

CHAP.

Chap. XXV.

The Golden rule compound of five Numbers.

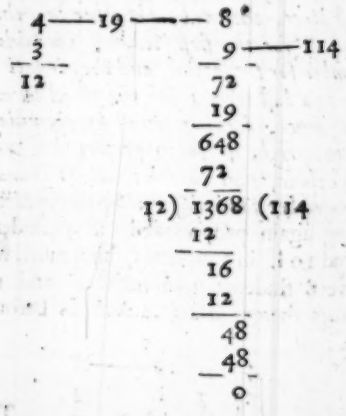
I. *THe Golden rule compound of five numbers is, when the termes being ranked, as before, in ſtead of the double termes we uſe their products, and then proceed to finde the terme required by one ſingle rule of Three.*

II. *Here when the queſtion propounded ought to be performed by the double rule direct, multiplying the termes of the firſt place, the one by the other take their product for the firſt terme, the middle number for the ſecond, and the product of the two laſt termes for the third terme; this done, having found by the rule of three direct, a fourth proportional unto thoſe three, that fourth terme ſo found is the number you look for*: So this queſtion being again propounded, if 4 ſtudents ſpend 19 l. in 3 moneths, how much will ſerve 8 ſtudents 9 moneths: and the termes thereof being ranked as before, viz. *thus*,

The Golden Rule compound of five Numbers performed by one ſingle Rule Direct.

4 —— 19 —— 8
3 9

The product of 4 multiplied by 3 is 12, and the product of 8 multiplied by 9 is 72; wherefore *I say*, As 12 to 19, so 72 to the terme required, which I finde by the single rule of *Three direct* to be 114. So that if 4 students spend 19 l. in three moneths, 114 l. will be requisite for the maintenance of 8 students 9 moneths, as you have it before resolved in the example of the 7 rule of the 23 Chapter aforegoing. See the whole operation, *as followeth*,



In

In like manner this being the *question* as before (in the last rule of the 23 Chapter.) If the carriage of 7 C. 128 miles, costs 48 s. what will the carriage of 3 C 32 miles stand me in? The *Answer* thereunto will be $5\frac{1}{2}$ s. as appears by the work.

128	48	32
7	96	3
896	288	96
	432	

896) 4608 (5
4480
128
896
17

III. *When the Question propounded ought to be resolved by the double rule Inverse, having multiplied the double termes a cross, that is, the uppermost term of the first place by the lower of the last, and the uppermost of the last place by the lower of the first, write each product under the lower terme by which it is produced, and then if the Inverse proportion be found in the uppermost line, using those products as single termes, proceed to finde the terme required by the single rule*

The Golden Rule compound of five Numbers performed by one single Rule Direct or Inverse.

of Three direct. But in case you finde the Inverse proportion in the lower line, perform the work by the single rule of Three Inverse.

So in the *example* above mentioned, if 9 bushels of provender serve 8 horses 12 dayes, how long will 24 bushels last 16 horses? Here if you rank the terms *thus*, you shall finde the *Inverse* proportion in the *first* line, as is observed in the last Chapter. And therefore having subscribed the products according to the direction given you in this Rule, I proceed to satisfie the demand of this question by the *single rule of Three direct*, as appears by the work *following*,

8	12	16
9		24

8—

8 —— 12 —— 16

9 24 —— 16

144 192

12

384

192

144) 2304 (16

144

864

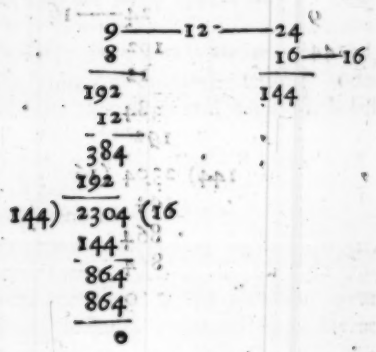
864

0

But the termes of this *question* being ranked thus; the *Inverse* proportion is found in the *lower* line, as you may observe likewise by the last Chapter; whereupon in this case to resolve the *question* I proceed by the *single rule of Three Inverse*, as appears by the work hereunto annexed: Howsoever therefore you work the question, you shall finde the *terme required* to be 16; so that at last I conclude, *as before* in the last Chapter. If 9 bushels of provender

9 — 12 — 24
8 16

vender ſerve 8 horſes 12 dayes, 24 buſhels will laſt 16 horſes 16 dayes.



CHAP.

CHAP. XXVI.

The rule of Fellowſhip.

1. *THe rules of Plural proportion are thoſe, by which we reſolve queſtions, that are diſcoverable by mo golden rules then one, and yet cannot be performed by the double golden rule mentioned before in the three laſt Chapters.* Of theſe *rules* there are divers kindes and varieties according to the nature of the *queſtion* propounded; for here the termes given are ſometimes four, ſometimes five, ſometimes mo, and the termes required ſometimes mo then one, &c. All which will more plainly appear when we ſhall deliver certain *examples* of theſe Rules in the inſuing part of this *Treatiſe*, whither we purpoſely refer you, becauſe there we ſhall have opportunity to reſolve *queſtions* of that kinde with much more facility by the help of the *Logarithmes*, then we are here able to do by the concluſions of *Natural Arithmetique*: Rules of Plural proportion.

Arithmetique: This in the *Interim* ſhall ſerve you for a light of theſe things, that when we have hereafter occaſion to mention *rules of plural proportion*, you may the better underſtand what is meant thereby.

II. *Two particular rules of plural proportion are theſe, the rule of Fellowſhip, and the rule of Alligation.*

The Rule of Fellowſhip.

III. *The rule of Fellowſhip is that, by which in accompts amongſt divers men (their ſeveral ſtocks together with the whole gain or loſſe being propounded) the gain or loſſe of each particular man may be diſcovered:* As in this *example*, *A* and *B* were ſharers in a parcell of merchandize, in the purchaſe of which *A* laid out 7 l. and *B* 11 l. and they having ſold this commodity, finde that their clear gains amounts to 54 s now here the queſtion to be reſolved by this Rule is, what part of that 54 s. accrues to *A*, and what to *B*, according to the Rate of the ſeveral ſums or *ſtockes* which they adventured? *Again*, *A*, *B*, and *C* fraight a ſhip from the *Canaries* for *England* with 108 Tuns of Wine, of which *A* had 48, *B* 36, and *C* 24; the *Mariners* meeting with a ſtorm at Sea, were conſtrained for the ſafety

ſafety of their lives, to caſt 45 Tunne thereof over boord: here the *queſtion* to be reſolved is, how many of the 45 Tunne each particular Merchant hath loſt according to the rate of his *adventure?*

IV. *The Rule of Fellowſhip is either ſingle or double.*

V. *The ſingle rule is, when the ſtocks propounded are ſingle numbers:* So the examples of the 3 rule aforegoing ought both to be performed by the *ſingle rule of Fellowſhip*, becauſe there 7 l. and 11 l. being the ſeveral *ſtockes* of the firſt example, and 48, 36, and 24 being the particular *ſtockes* of the laſt, are all ſingle numbers. 1. Single.

VI. *In the ſingle rule of Fellowſhip take the total of all the ſtockes for the firſt terme, the whole gaine or loſſe, for the ſecond, and the particular ſtocks for the third termes; this done, repeating the rule of Three ſo often, as there are particular ſtockes in the queſtion, the fourth termes produced upon thoſe ſeveral operations are the reſpective gains or loſſes of thoſe particular ſtockes propounded:* So in the firſt *example* above mentioned 7 l. and 11 l. are the *ſtockes* propounded, whoſe How to work this Rule.

whose total is 18 l. which I take for the first terme; Againe 54 s. the common *gain*, is the second terme, and 7 l. the first particular *stocke*, is the third terme of the first *proportion*; whereupon I say, as 18 l. to 54 s. so 7 l. to another number, which by the direct rule of *Three* I finde to be 21 s. *viz.* the part of the *gaine* due to *A*, that expended the 7 l. *stocke*. Then for the second *proportion* I say, as 18 l. to 54 s. so 11 l. to another number, which I likewise finde by the rule of *Three* direct to be 33 s. *viz.* the part of the *gain* due to *B* for his 11 l. *stock*.

7 } 18—54—Therefore { 7—21
11 } { 11—33

Again in the other premised example, the particular losse that happens to *A* is 20 Tunne, to *B* 15, and to *C* 10 Tunne,

48 }
36 } 108—45—Therefore { 48—20
24 } { 36—15
{ 24—10

2. Double. VII. *The double rule of Fellowship*

is,

is, when the ſtocks propounded are double numbers, viz. when each ſtock hath relation to a particular time: Example, A, B *and* C, hold a paſture in common, for which they pay 45 l. *per annum.* In this paſture *A* had 24 Oxen went 32 dayes, *B* had 12 there 48 dayes, and *C* had 16 Oxen there 24 dayes; now the *queſtion* to be reſolved by this *Rule*, is, what part each of theſe Tenants ought to pay of the 45 l. rent? And here you may obſerve, that the ſtockes propounded are *double* numbers, *viz.* each ſtock of Oxen hath reference to a *particular* time, for the reſpective ſtock of *A* is 24 Oxen, and its *particular* time is 32 dayes; again the ſtock of *B* is 12 Oxen, and the *reſpective* time is 48 dayes; and laſtly, the ſtock of *C* is 16 Oxen, and its *peculiar* time is 24 dayes, which as you ſee are *double* numbers.

How to work the ſame Rule.

VIII. *In the double rule of Fellowſhip multiply each particular ſtock by its reſpective time, and take the totall of their products for the firſt terme, the whole gain or loſſe for the ſecond, and the ſaid particular products of the double numbers for the third terms: This done, repeating, as before, the Rule of Three,*

ſo

so often as there are products of the double numbers; the fourth terms produced upon those several operations, are the numbers you look for: So in the *example* of the last rule, the product of 24 and 32, is 768, the product of 12 and 48, is 576, and the product of 16 and 24, is 384, the sum of these products is 1728, which is the *first terme* in the question, then 45 l. the rent is the *second terme*, and 768 the *first product*, is the *third terme* of the first proportion. Wherefore *I say*, As 1728 to 45 l. so 768 to another number, which I finde by the direct rule of *Three* to be 20 l. *viz.* the part of the rent that *A* ought to pay: Then for the second proportion *I say*, As 1728 to 45 l. so 576 to 15 l. which is the part that *B* ought to *pay*: And lastly, As 1728 to 45 l. so 384 to 10 l. *viz.* the part that *C* must *pay*,

768 }
576 } 1728 — 45 — Therefore { 768-20
384 } { 576-15
{ 384-10

The Proof. IX. *The rule of Fellowship is proved by Addition of the termes required*, whose *sum* ought to be equal to the *second terme*

in

in the question, otherwise the whole work is erroneous: So in the first *example* of the 6. Rule aforegoing 21, s. and 33, s. being added together are equall to 54, s. the *second terme* in that question: Likewise in the last *example* of the same Rule, as also in the *example* of the last Rule, the *summe* of 20, 15, and 10, the termes required is equall to 45, the *second terme* propounded.

CHAP. XXVII.

The Rule of Alligation.

I. *THe Rule of Alligation is that, by which we resolve questions, that concerne the mixing of divers simples together.*

II. *Alligation is either Mediall, or Alternate.*

III. *Alligation Mediall is, when having the severall quantities and rates of divers simples propounded, wee discover the mean rate of a mixture compounded of those simples.* So 10 bushels of wheat at 4, s. or (which is all one) 48, d. the bushell, 40 bushels of rye at 3, s. or 36, d. Alligation Mediall.

the buſhell; and 50 buſhels of barley at 2, s. or 24, d. the buſhell; being mixed with 20 buſhels of oates at 12, d. the buſhell, the Rule of *Alligation mediall* ſheweth you the meane price of that miſtling.

The operation and proportions of the ſame Rule.

IV. *In Alligation mediall firſt ſumme the given quantities, then finde the totall value of all the ſimples: this done, the proportion will be as followeth.*

As the ſumme of the quantities is to the totall value of the ſimples:

So is any part of the mixture propounded to the required mean rate, or price of that part.

Repeating again the premiſed example of the third rule, I demand how much one buſhell of that miſtling is worth? Now the ſumme of 10, 40, 50, 20, (the given quantities) is 120 buſhells: and the value of the 10 buſhels of wheat at 48, d. the buſhell, amounts to 480, d. for 48 being multiplyed by 10, the product is 480: again the value of the 40 buſhell of rye at 36, d. the buſhell is 1440, d. The value of the 50 buſhels of barley at 24, d. the buſhell is 1200, d. And the value of 20 buſhels of oates at 12, d. the buſhell is 240, d. All theſe values being added together,

gether, their totall is 3360, d. I say then by the rule of *Three direct*, If 120 bushels give 3360 d. what will 1 bushell yeeld? The *Rule* presently answers me 28, d. whereupon I conclude, that a bushell of that mistling may bee afforded for 28, d. that is, 2, s. 4, d. which is the resolution of the *question propounded.*

120——3360——1——28

In like manner if it bee demanded what 8 bushels or a quarter of that mistling is worth? The *Answere* will bee 224, d. which being divided by 12, and by that meanes reduced into *shillings*, is 18, s. 8, d.

120——3360——8——12) 224(18

12

104

96

8

The proof.

V. *In Alligation Mediall, the triall of the work is by comparing the totall value of the severall simples with the value of the whole mixture*: For when those sums accord, the operation is perfect: So in the *example* of the last rule,

		l.	s.	d.
The value of	10 bushels of wheat at 4 s. the bushell is	2	0	0
	40 bushels of Rye at 3 s. the bushell is	6	0	0
	50 bushels of barley at 2 s. the bushell is	5	0	0
	And 20 bushels of oats at 12 d. the bushel is	1	0	0
	All which amount to	14	0	0

which is likewise the value of 120 bushels at 28 d. or 2 s. 4 d. the bushell, for that also amounts to 14 l.

Alligation Alternate.

VI. *Alligation Alternate is, when having the severall Rates of divers Simples given, we discover such quantities of them, as are necessary to make a mixture, which may beare a certaine rate propounded.*

Example: A man being determined to mixe 10 bushels of wheat of 4 s. or 48 d. the bushell, with rye of 3 s. or 36 d. the bushell, with Barley of 2 s. or 24 d. the bushell, & with Oats of 1 s. or 12 d. the bushell, the rule of *Alligation Alternate* will discover unto you how much Rye, how much Barley, and how much Oates he ought to adde unto the 10 bushels of Wheat; in such sort that the mix-

ture of them all together may beare a certain rate or price propounded.

VII. *In questions of Alligation alternate, you must ranke the termes in such sort that the given rate of the mixture may represent the roote, and the severall rates of the Simples may stand as branches issuing from that root*: So the example of the last rule being propounded, I demand how much Rie, Barley and Oates ought to be added to the 10 bushels of Wheat, that the mixture of all together may beare the rate or price of 28 d. or 2 s. 4 d. the bushell: And therefore drawing a line of connexion, I place 28 d. the given rate of the mixture, upon the left hand thereof by it self representing the *roote*, and likewise write the other rates propounded, *viz.* 48 d. 36 d. 24 d. and 12 d. one above another upon the right hand of that line of Connexion, which rates are conceived to issue from 28 d. as branches from the roote, the fabrick hereof appeares plainly in the margent?

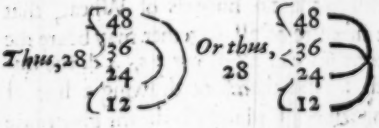
The right ordering of the termes.

28 { 48, 36, 24, 12 }

VIII. *Having ranked the termes in*

How to couple the termes.

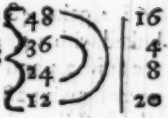
their due order, linke the branches together by certain Arkes, in such sort that one that is greater then the roote or rate of the mixture, may alwayes be coupled with another that is lesse then the same: So in the premised example 48 may be linked with 12, and 36 with 24. or otherwise 48 may be coupled with 24. and 36 with 12, and then the work will stand,



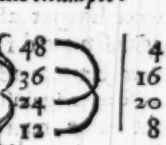
How to order the differences.

IX. *Having alligated the branches and found the differences betwixt them and the root, write the difference of each branch just against his respective yoke-fellow.* So the branches of the example aforegoing being linked after the first manner, and the difference between 28, and 48, (by the sixth Rule of the eighth Chapter of this Book) being 20, I place 20 just against 12 the respective yoke-fellow of 48. Againe, 16 being the *difference* betwixt 28 and 12, I write it just against 48: In like manner 8 being the difference between

between 28 and 36 I place it right against 24. And lastly 4 the *difference* betwixt 28, and 24, I write just against 36: In the end the whole *Fabricke* of the worke (as the branches are thus linked) will stand as in the *example*.



But the branches being linked after the other manner, the worke will bee *thus* disposed:



For in this case 48 hath 24 for his *yoke-fellow*, and the respective *Camerado* of 36 is 12: and here the interchangeable placing of the *differences* (as in the premised examples) is that which is more particularly termed *Alternation*.

X. *When one branch is linked to divers other branches, and not to one alone, the differences ought to be as often transcribed, as it is so diversly linked.* So in the premised *example*, the branches being linked after the last manner, you may (if you please) conceive 12 to be coupled both

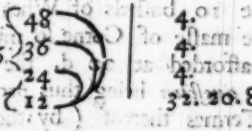
with 48 and 36; likewise 24 may be conceived to be linked with the same 48, and 36: Again, 48 may be understood to be linked with 24, and 12, as also 36 with the same 24 and 12: wherefore the *difference* betwixt 28 and 12 being 16, I write it both just against 48 and 36: In like manner the *difference* between 28 and 24 being 4, I write it likewise over against the same numbers: Again 20 being the difference betwixt 28 and 48, I place it just against 24 and 12; and 8 being the *difference* between 28 and 36, I write it likewise over against the same numbers: All this performed, the whole *frame* of the worke will stand as in the *Margent*:

28	48	16.	4
	36	16.	4
	24	20.	8
	12	20.	8

2. Take this for another *example*: it is required to *mixe* 10 bushels of Wheat at 48 d. the bushell with Rie of 36 d. the bushell, with Barley of 24 d. the bushell, and with Oates of 12 d. the bushell, and the *question* now is, how much Rie, Barley and Oates ought to bee added to the 10 bushels of Wheat, that the intire *mixture* may

may bee afforded at 16 d. the buſhell; Here the branches of this *queſtion* (according to the 8th. Rule of this Chapter) ought to be linked *thus*,

And as for the *Alternation* of the differences, it is evident (by the preſent Rule) that the *difference* between 16 and 12 being 4, ought to be thrice tranſcribed, *viz.* firſt juſt againſt 48, then againſt 36, and laſt of all againſt 24. Again 32 the *difference* betwixt 16 and 48, as alſo 20 the *difference* between 16 and 36, and laſtly 8 the *difference* betwixt 16 and 24, ought all to be placed juſt againſt 12.



3. I determining to mixe 10 buſhels of Wheat at 48 d. the buſhell with Rie of 36 d. the buſhell, with Barley of 24 d. the buſhell, and with Oates of 12 d. the buſhell, deſire to know how much of each

I ought

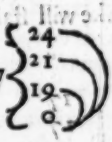
I ought to take, that I might afford the whole mixture at 40 d. the buſhell: here the whole worke being ordered according to the Rules aforegoing, it will ſtand as *followeth*:

4. A man intending to mixe 10 buſhels of Wheat at 48 d. the buſhell, with Rie of 36 d. the buſhell, with Barley of 24 d. the buſhell, with Peaſe of 16 d. the buſhell, and with Oates of 12 d. the buſhell, deſires to know how much Rie, Barley, Peaſe and Oates he ought to adde to the 10 buſhels of Wheat, that the whole maſſe of Corne ſo mixed might bee afforded at 20 d. the buſhell? This *queſtion* being thus propounded, the Termes thereof (by the Rules aforegoing) may bee *Alligated*, and the differences of the Termes *Alternated*, as *followeth*,

5. Lastly, a Goldsmith hath some Gold of 24 carects, other of 21 carects and other some of 19 carects fine, which he would so mixe with *Alloy*, that 120 Ounces of the intire *mixture* might beare 17 carects fine; now the *question* is, how much of each sort, as also how much *Alloy* he must take to accomplish his desire? Before you can well understand this *question*, it will be necessary to explain what a *Carect fine*, and what *Alloy* is: The Mint-Masters and Goldsmiths to distinguish the differing *finenesse* of Gold esteem an intire Ounce to containe 24 *Carects*, and an Ounce of Gold that being tried in the fire loseth nothing of the waight is said to be 24 *Carects fine*, again the Ounce that being tried loseth one foure and twentieth part of the waight, is said to bee 23 *Carects fine*: In like manner that which loseth $\frac{2}{24}$ of the Ounce, is esteemed to bee 22 *Carects fine*, and so consequently of the

What a Carect fine, and what Alloy is.

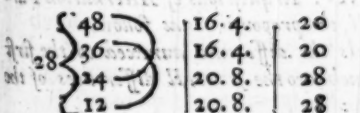
the reſt: And as for *Alloy* it is ſilver, copper, or ſome other baſer metall, with which the Goldſmiths uſe to mixe their Gold, to the intent they may moderate, or abate the *fineneſſe* thereof. Here you may alſo obſerve that as the *fineneſſe* of *Gold* is meaſured by *Carects*, ſo is the *fineneſſe* of *Silver* eſtimated by *Ounces*: In ſuch ſort that a *pound* of *Silver*, which being *tried* a certain time in the fire loſeth nothing of the *waight*, is ſaid to bee 12 *Ounces fine*. But a *pound* that being tried loſeth ſomewhat of the *waight* is ſaid to bee the *remainder* of the *waight fine*. *Example*, a *pound* of *Silver* that loſeth in the fire one *Ounc.* 8 p. is eſtimated to be 10 *Ounc.* 12 p. *fine*, and that which loſeth 2 *Ounc.* 8 p. 10 *Grains*, is ſaid to be 9 *Ounc.* 11 p. 14 *Grains fine*, &c. Now to ranke the termes of the laſt mentioned *queſtion*, as alſo the differences of the termes in their due order, becauſe the three given branches (*viz.* 24 *Carects*, 21 *Carects*, and 19 *Carects*) are all greater then 17 *Carects* the *root* or rate of the *mixture*. I adde 0, as another branch which I conceive to be leſſe then the *root*, and then proceed as in the former operations; the whole *frame* of the worke is expreſſed here, as followeth:



XI. *When in one and the ſame line there are found more differences then one, adde them together, and write the ſumme juſt againſt the ſame differences before a ſtraight line drawne towards the right hand of the work.*

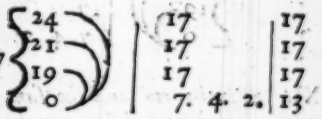
How to adde the differences.

So the firſt *example* of the laſt rule being propounded, the ſumme of 16, and 4, (the differences placed juſt againſt the firſt branch) being 20, I write it over againſt the ſame *differences* before the new line drawn upon the right hand of the work, and ſo conſequently the reſt in their due order, as appears by the *example* hereunto annexed:



In like manner the laſt *example* of the laſt Rule being offered, the whole Fabricke

bricke of the worke will ſtand, as followeth :



XII. *Alligation Alternate is either Partiall or Totall.*

Alternation partiall.

XIII. *Alternation Partiall is, when having the ſeverall rates of divers Simples, and the quantitie of one of them given, we diſcover the ſeverall quantities of the reſt, in ſuch ſort that a mixture of thoſe Simples being made according to the quantity given, and the quantities ſo found, that mixture may beare a certaine rate propounded:* Of this kinde is the *example* of the ſixth rule, as alſo all the *examples* of the 10 rule except the laſt.

The proportions uſed in this rule.

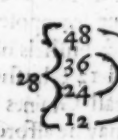
XIV. *In queſtions of Alternation Partiall, the proportion is as followeth :*

As the difference annexed to the firſt branch is to the ſeverall differences of the reſt :

So is the quantity propounded to the ſeverall quantities required.

So the *example* of the ſixth and ſeventh rules

rules of this Chapter being again repeated, and the *Termes* thereof, as alſo the *differences* of the *Termes* being ordered after the firſt manner (ſhewed you in the ninth rule aforegoing) It is evident that for every 16 buſhels of Wheat that I take in the *mixture*, I ought to take 4 buſhels of Rie, 8 buſhels of Barley, and 20 buſhels of Oates; And therefore *I ſay*,



The firſt Caſe.

I. As 16 the *difference* annexed to the firſt branch (being the rate of the Wheat) is to 4 the *difference* annexed to the next, being the rate of the Rie; So is 10 the given quantity of the Wheat to another number, which being found by the rule of *Three direct* to be 2 $\frac{1}{2}$ (that is 2 buſhels and an half) is the quantity of Rie neceſſary in the *mixture*.

II. As 16 to 8, ſo is 10 to another Number, which being likewiſe found by the Rule of *Three* to bee five buſhels, is the quantitie of Barley, neceſſarie in the *mixture*.

III.

III. As 16 to 20, ſo is 10 to another Number, which being in like ſort found by the Rule of *Three* to be 12 $\frac{24}{32}$ (that is 12 buſhels and halfe of a buſhell) is the quantity of Oates requiſite in the *mixture*.

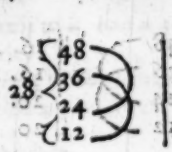
So that at laſt I conclude a *heap* of Corne being compoſed of 10 buſhels of Wheat, 2 $\frac{1}{2}$ buſhels of Rie, 5 buſhels of Barley, and 12 $\frac{1}{2}$ buſhels of Oates (when thoſe ſeverall Graines beare the *prices* aforeſaid) may be afforded at 2 s. 4 d. the buſhell.

2. caſe. 2. The ſame *Example* being ordered after the ſecond manner (expreſſed likewiſe in the ninth rule of this preſent Chapter) *I ſay*;

I. As 4 the *difference* annexed to the *rate* of the Wheat, is to 16 the *difference* annexed to the *rate* of the Rie; ſo is 10 the *given* quantity of the Wheat, to 40 buſhels the *required* quantity of the Rie.

II. As 4 to 20, ſo is 10 to 50 buſhels, the *requiſite* quantitie of the Barley.

III. As 4 to 8, ſo is 10 to 20 buſhels, the quantity of the Oates *neceſſary* in the mixture.



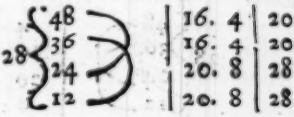
So that I conclude *again*, a maſs of Corn being compounded of 10 buſhels of wheat, 40 buſhels of Rye, 50 buſhels of Barley, and 20 buſhels of Oats, (when thoſe grains bear the prices propounded in this *example*) may be afforded at 2 s. 4 d. the buſhel, as *before*.

3. That example being diſpoſed after the third manner (expreſſed in the 10 and 11 rules of this chapter) I ſay; 3 Caſe.

I. As 20 the *ſums* of the differences annexed to the *rate* of the Wheat, is to 20 the *ſum* of the differences annexed to the *rate* of the Rye; ſo is 10 the *given* quantity of the wheat, to 10 buſhels the *required* quantity of the Rye.

II. As 20 to 28, ſo is 10 to 14 buſhels the *requiſite* quantity of the barley.

III. As 20 to 28, ſo is 10 to 14 buſhels, the quantity of Oats *demanded* in the mixture.



Whereupon this *third time* likewise I conclude, that (those grains ſtill retaining the given rates) 10 buſhels of Wheat, 10 buſhels of Ry, 14 buſhels of Barley, and 14 buſhels of Oats being all *mixed* together, will conſtitute a *maſs* of Corn, that may be afforded at 28 d. or 2 s. 4 d. the buſhel.

By this example thus *diverſified* it plainly appears, that the quantities *required* may be altered as often, as the queſtion given will admit divers *Alligations*, and yet the *mixture* produced will ſtill hold the *rate* propounded; but when the *queſtion* propounded will admit but one onely way of *Alligation*, the quantities required to make the *mixture*, cannot be varied; ſo the ſecond *example* of the 10 rule of this Chapter being again produced, and ordered according to the direction of the 11 rule aforegoing, *I ſay*,

I. As 4 to 4, ſo 10 to 10 buſhels of Rye.

II. As

II. As 4 to 4, so 10 to 10 bushels of Barley.

III. As 4 to 60, so 10 to 150 bushels of Oats.

48	4	4
36	4	4
24	4	4
12	32. 20. 8.	60

So that for this question *I conclude*, to 10 bushels of Wheat you ought to adde 10 bushels of Rye 10 bushels of Barley, and 150 of Oats, to the end that a *mixture* of Corn might be made, which may be sold at 16 d. the bushel: And here the quantities found (*viz.* 10, 10, and 150) cannot be *altered*, because the termes of this question will not admit any other variety of *Alligation*.

XV. *In Alternation partial, the proof is likewise by comparing the total value of the severall simples, with the value of the whole mixture*: So in the second *example* of the last Rule the total *value* of the 10 bushels of Wheat, 40 bushels of Rye, 50 bushels of Barley, and 20 bushels of Oats amounts to 14 l. which is also the value of the whole mixture at 2 s. 4 d. the bushel, The Proof.

as appears by the *example* of the fifth rule of this present Chapter.

Alternation Total.

XVI. *Alternation total is, when having the total quantity of all the simples together with their several rates, we produce their several quantities, in such sort, that a mixture of them being made according to the quantities so found, that mixture may bear a certain rate propounded:* Of this sort is the last *example* of the tenth Rule aforegoing; as also *this*, A Goldsmith having divers sorts of Gold, *viz.* some of 24 carects, other of 22 carects, some of 18 carects, and other some of 16 carects *fine*, is desirous to melt of all these sorts so much together, as may make a *mass* containing 60 ounces of 21 carects *fine*: Now this Rule of *Alternation total* sheweth you how much you are to take of each sort, to the end the whole *masse* may contain just 60 ounces of 21 carects, the *finesse* propounded.

The Proportions.

XVII. *In questions of Alternation total the Proportion is, as followeth;*

As the sum of all the differences is to the total quantitie of all the simples: So is the correspondent difference of each rate to the respective quantity of the same rate.

So

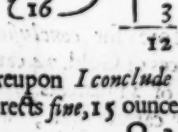
So the last *example* of the last Rule being propounded, *I say*,

I. As 12 the sum of the differences is to 60 ounces the *Total* quantity of all the simples; so is 5 the correspondent *difference* of 24 carects the first rate, to 25 ounces, *viz.* the required quantity of the Gold of the same rate, which may be taken to make the *mixture* propounded.

II. As 12 to 60, so is 3 the correspondent *difference* of 22 carects the second rate; to 15 ounces, *viz.* the quantity of the Gold of 22 carects that ought to be used in the *mixture*.

III. As 12 to 60, so is 1 to 5 ounces of the Gold of 18 carects *fine*.

IV. As 12 to 60, so is 3 to 15 ounces of the Gold of 16 carects *fine*, which are requisite to be taken for the *mixture* propounded.



Whereupon *I conclude* that 25 ounces of 24 carects *fine*, 15 ounces of 22 carects,

5 ounces of 18 carects, and 17 ounces of 16 carects *fine*, being all melted together will produce a *masse* of Gold containing 60 ounces of 21 carects *fine*; which is the resolution of the *question* propounded.

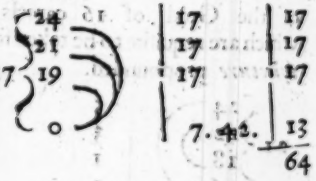
Again, the last *example* of the tenth Rule being here repeated, and ordered according to the direction of the eleventh Rule, *I say*,

I. As 64 to 120, so is 17 to 31 $\frac{15}{64}$ ounces of 24 carects *fine*.

II. As 64 to 120, so is 17 to 31 $\frac{15}{64}$ ounces of 21 carects *fine*.

III. As 64 to 120, so is 17 to 31 $\frac{15}{64}$ ounces of 19 carects *fine*.

IV. As 64 to 120, so is 13 to 24 $\frac{45}{64}$ ounces of *Alloy*.



And therefore for *conclusion* I say, that 31 $\frac{15}{64}$ ounces of Gold, 24 carects *fine*, 31 $\frac{15}{64}$ ounces of 21 carects *fine*, 31 $\frac{15}{64}$ ounces of 19 carects *fine*, and 24 $\frac{45}{64}$ ounces

ounces of *Alloy* being all mixed together, will produce a mass containing 120 ounces of Gold 17 carects *fine*, which is the satisfaction of the *question* premised.

And here *observe* (as before in the exposition of the fourteenth rule of this Chapter) that the operations of the first of these examples may be *varied* according to the diversity of the *Alligations* which it will admit, whereas the last example is not subject to any *variety*, the *Alligations* thereof remaining always the same.

XVIII. *Here the operation is perfect, when the sum of the quantities found agrees with the total quantity propounded:* So in the first *example* of the last rule, 25, 15, 5, and 15, (the quantities found) being all added together amount to 60, which is the total quantity propounded. The Proof.

Chap. XXVIII.

The Rule of False.

Vide supra, cap. 2. nu. 3.

I. THus far *Arithmetique Positive: Negative insues, which being also termed the Rule of False, is always performed by false and supposititial numbers afterwards invented, viz.* after the proposition is made, and the question propounded: For things are said to be found out by the *Rule of False*, when by false termes *supposed*, we *discover* the true terms *required*.

II. *The Rule of False is either of single or double position.*

The Rule of single Position.

III. *The Rule of single position is, when at once*, viz. *by one false position we have means to discover the true resolution of the question propounded.*

For example, *A*, *B*, and *C* determining to buy together a certain quantity of timber, that should cost them 36 l. agree amongst themselves that *B* shall pay of that sum a *third* part more then *A*, and that *C* shall pay a *fourth* more then *B*. Now the *question* is, what particular sum each

each of these parties ought to pay of the 36 l. To resolve this *question*, first, put the case that *A* ought to pay 6 l. of the 36 l. and then *B* must pay 8 l. because he payes $\frac{1}{3}$ more then *A*. And lastly *C* ought to pay 10 l. because he is to lay out $\frac{1}{4}$ more then *B*. This done, although by addition of these three sums, *viz.* 6, 8, and 10, I finde that I have made a wrong *position* (their totall amounting onely to 24 l. which ought to have been 36 l.) nevertheless by those *suppositiall* Numbers I have means to discover the true sums which the severall parties ought to pay: for *I say* by the rule of *Three Direct*,

I. As 24 to 36, so is 6 to 9 l. the *part* that *A* must pay.

II. As 24 to 36, so 8 to 12 l. the *part* that *B* ought to pay.

III. As 24 to 36, so is 10 to 15 l. the *part* of the 36 l. that *C* must pay.

IV. *Here for triall of this Rule the totall of the sums found ought to accord with the sum given*: so in the example of the last rule, 9, 12, and 15 being all added together amount to 36, the *sum* propounded. The proofe.

V. *The Rule of double Position is, when two false Positions are supposed for the resolution of the question propounded.* As in The Rule of double Position.

this

this, A workman having threshe out 40 quarters of Graine (*part* thereof being Wheat, and the rest Barley) received for his labour 28 s. being paid after the rate of 12 d. for every quarter of Wheat, and 6 d. for each quarter of Barley: Now here the question is how many of those 40 quarters were Wheat, and how many Barley: Here therefore I first suppose at randome that there was 26 quarters of Wheat, and 14 of Barley, and then to discover whether I have guessed right or wrong, I finde how much money is due unto the workman at the rate of 12 d. the quarter of Wheat, and 6 d. the quarter of Barley, which I find to be 33 s. (*viz.* 26 s. for the 26 quarters of Wheat, and 7 s. for the 14 quarters of Barley) which he ought to have received, if my *supposition* had been right; but because it differs from 28 s. the true sum that he received, I perceive I have mist the marke, and therefore discovering how much I have err'd by finding the *difference* betwixt 28 s. and 33 s. I keep in mind 5 their *difference*, which is called the *first error* or the *error of the first Position:* Again I propound for the *second Position*, that there was 30 quarters of Wheat, and 10 quarters of Barley, and then the *second error* I find to be 7; for there

there is then due to the workman for the 30 quarters of Wheat 30 s. and for the 10 quarters of Barley 5 s. in all 35 s. which *differs* from 28 s. the true sum that he received, 7 s. and here by these two *false Positions*, together with their *errors*, you may discover how many quarters of Wheat, and how many of Barley the workman thresht, as shall be farther explained by the *Rule following.*

VI. *In the Rule of double Position having drawn two lines acrosse, and placed the termes of the false Position* (viz. *those that have the same Denomination*) *at the uppermost end of that crosse, as also each error under his respective Position at the lower end of the same crosse, multiply each error by the contrary Position; that is, the second error by the first Position, and the first error by the second Position; this done, when both the errors are of one and the same kind,* (viz. *both excesses or both defects*) *subtract the lesse Product out of the greater, and then the remainder is your Dividend; but if the errors be of differing kinds,* viz. *one of them an excesse, and the other a defect, add those Products together, and then the sum will be your Dividend, which if you divide by the difference of the errors* The Operation.

errors (when they are of one and the same kinde) or by their summe (when they are of differing kindes) the quotient will give you a number you looke for, having the same Denomination with the false Positions placed at the upper end of the crosse.

1. *Example*, The question of the last rule being againe propounded, I place these termes, *viz.* 26 (having the Denomination of the quarters of Wheat in the *first Position*) and 30 (having the same Denomination in the *second Position*) at the upper end of the *Crosse*: As also 5 and 7 the two errors respectively under them at the lower end of the same *Crosse*, as you may see it exemplified by the pattern *following*:

Note that this Character —— is a Signe of dissolution, signifying that the Numbers betwixt which it is found ought to be subtracted the one out of the other.

This done having multiplied 26 by 7, the *Product* is 182, and likewise 30 by 5 the

the *Product* is 150, which being deducted out of 182 (becauſe the *errors* here are both of the ſame ſame kinde, *that is*, are each of them an *exceſſe* above 28 s. the ſumme that the workman received) the *remainder* is 32, which being divided by 2 (the difference betwixt 5 and 7 the two errors.) leaves in the *quotient* 16, for the quarters of *Wheat* that the workman threſht, whoſe complement to 40, *viz.* 24. are the quarters of *Barley*, that he likewiſe threſht: ſo at laſt I conclude, the workman receiving 28 s. for his wages in threſhing out 40 quarters of grain (being part Wheat, part Barley) at 12 d. the quarter of Wheat, and 6 d. the quarter of Barley, threſhed in all 16 quarters of Wheat, and 24 quarters of Barley.

2. *Example*, the ſame queſtion being again propounded, I ſuppoſe for my *firſt Poſition* that there are 8 quarters of Wheat, and 32 quarters of Barley, and then the *firſt error* will be 4 s. for 8 s. being accompted for the eight quarters of Wheat, and 16 s. for the 32 quarters of Barley, make in all 24 s. which wants 4 s. of 28 s. the ſum received: Again, *ſuppoſing* that there are 12 quarters of Wheat, and 28 quarters of Barley, the *ſecond error* will be

be 2 s. for 12 s. being allowed for the 12 quarters of Wheat, and 14 s. for the 28 quarters of Barley, the ſum is 26 s. which comes 2 s. ſhort of 28 s. the right ſumme: Now then 8 being multiplied by 2, the *Product* is 16, likewiſe 12 by 4 *produceth* 48, out of which if you deduct 16 (becauſe *the errors* in this caſe happen to be both *defects* under 28 s. the ſum received) the *remainder* is 32, which being divided by 2 (the difference of the errors) gives you in the quotient 16, *viz.* the quarters of wheat, *as before*:

3. *Example*, the ſame demand being the third time produced, I take for my *firſt Poſition* 10 quarters of Wheat, and 20 quarters of Barley, and then proceeding as before, the *firſt error* will prove 3 s. which upon that *Poſition* I want of 28 s. the right ſum;

ſum: Again, here for the *ſecond Poſition* I take 26 quarters of Wheat, and 14 quarters of Barley, and then the *ſecond error* will be 5 s. which upon that *Poſition* I have exceeded 28 s. the true ſumme: Now then multiplying 10 by 5, the *Product* is 50, and 26 by 3, the *Product* is 78: And here (becauſe the *errors* are of differing kinds, one of them being a *defect*, and the other an *exceſſe* of 28 s. the true ſumme) you are to adde 50 and 78 the two *Products* together, whoſe ſum is 128, which being divided by 8 the ſum of 3 and 5 the two *errors*, gives you in the quotient 16 for the quarters of Wheat, *as before* in the former reſolutions. So that what *Poſitions* ſoever you take in this *Queſtion*, you ſhall alwayes finde that the workman threſhed 16 quarters of Wheat, and 24 quarters of Barley, which is the reſolution of the *queſtion* propounded.

Note that this Character + is a ſigne of connexion, intimating that the numbers betwixt which it is found, ought to be added together.

VII.

VII. *Here the triall is the same with that which is used in finding out the errors:* So in the *example* premised 16 and 24 being the numbers found, and 16 s. being allowed for the 16 quarters of Wheat, likewise 12 s. for the 24 quarters of Barley, their sum is 28 s. which was the sum received by the *workman*.

Thus have we past through all the chief parts of *Naturall Arithmetique*, in the exemplification whereof we have been the briefer, because we shall have occasion to use varieties of *examples* in the second Book, which treateth of *Artificiall* or *Logarithmeticall Arithmetique*, whereby you may resolve any question propounded in *broken* and *mixt* numbers, with little more difficultie then those propounded in *whole* numbers, as shall be further declared in the second Book.

An

An Appendix.

CHAP. I.

Of Rules of Practice, or Compendious Operations upon the Rule of Three.

IN the Rule of Three as well Direct as Inverse, when the Divisor with either of the other two Terms may be divided by some common measure without leaving any remainder, the quotient may be taken for new Terms, and proceeding in like manner as often as is possible, the Operation according to the ninth Rule of the one and twentieth Chapter; or the 2d Rule of the two and twentieth Chapter, will be much contracted, as is manifest by the subsequent Examples.

Question 1. If 24 yards of cloth cost 11 l. what will 52 yards cost at that rate?

y.	*l.*	*y.*
14	21	52
2	3	52
1	3	26

Facit 78 *pounds.*

In the aforesaid Operation you may observe, that the *Divisor* 14 and the second *terme* 21 being divided by their common measure 7, the three termes will be 2,3,52; Again, the *Divisor* 2, and the *third terme* 52, being contracted by their *common measure* 2, the three *termes* will be 1,3,26; Lastly, proceeding according to the 9th. rule of the 21th. Chapter, the fourth proportionall or answer of the question will be found 78.

Quest. 2. If 21 *Men* will finish a work in 16 dayes, in what time will 12 *Men* perform the same?

Facit 28 dayes.

Men	*Dayes*	*Men.*
21	16	12
7	16	4
7	4	1

Facit 28 *dayes.*

By the aforesaid Operation you may observe

observe, that the *Divisor* 12, and the *first terme* 21, being contracted by 3, the three termes will be 7, 16, 4; Again, the *Divisor* 4, and the *second terme* 16, being contracted by 4, the three terms will be 7, 4, 1. Lastly, working by the 2d *Rule* of the 22. *Chapter*, the answer of the question will be found 28 *dayes*.

II. In the *Rule* of *Three Direct* or *Inverse*, when the *Divisor* and either of the other two *termes* are Fractions having a common *Denominator*, the said *Denominator* may be rejected and the *Numerators* reduced to new termes.

Question 3. If $\frac{3}{4}$ of an Ell of *Scarlet* be worth 5 s. what is the value of $\frac{5}{8}$ of an Ell of the same *Scarlet*?

Facit 12 s. 10 d.

3 —— 60 —— 5
1 —— 22 —— 7

Facit 15 *terme* or 12 s. 10 d.

Question 4. If 3 yards of *Scarlet* cost 1 l. what is the price of one yard at that rate?

Facit 21. 6 s. 8 d.

11/4 —— 11/4 —— 1
15 —— 35 —— 1
3 —— 7 —— 1
Facit 2 1/3 l.

I might proceed to shew divers briefe Operations in the *Rule* of *Three*, where one of the *Termes* is 1 or unity, which Contractions will bee obvious to such as are exercised in *Arithmetique*, and skilfull in *Proportion*, but would bee as a wildernesse of *Rules* to *Learners*, and therefore I shall onely mention a few *examples*, some of which may bee practised by the ingenious, although they have but little knowledge in *Arithmetique*, and may bee sufficient to inform them how to resolve other questions of like nature.

Question 5. At 17 s. 9 d. the yard, what will 84 yards cost? ——— 5

Facit 74 l. 11 s. ——— 1

Here reason sheweth that 84 yards must cost 84 *Angels*, 84 *Crownes*, 84 *halfe Crownes*, and 84 *three-pences*; all which being computed and added together, will give the full cost of 84 yards.

Facit 1 l. 8 s. 8 d.

84

	l.	s.	d.
84 *Angells* make	42	00	00
84 *Crownes* make	21	00	00
84 *Half-Crowns* make	10	10	00
84 *Three-pences* make	1	01	00
Summe	74	11	0

Question 6. At 9 s. the *Bushell* of *Wheat*, what will 51 *quarters* amount unto? *Facit* 183 l. 12 s. 0 d.

First finde the price of 1 *quarter* which will be 8 *Angells* wanting 8 *shillings* viz:

	l.	s.	d.
8 *Angells* make	4	00	00
Out of which deduct	0	08	00
Rem. the price of 1 *quart.*	3	12	00

Then finde what 51 *quarters* will amount unto at 3 l. 12 s. 0 d. the *quarter*, thus;

	l.	s.	d.
51 times 3 l. or 3 times 51 l. is	51	00	00
	51	00	00
	51	00	00
51 *Angels* make	25	10	00
51 *shillings* doubled make	5	02	00
The price of 51 *quarters*	183	12	00

Tare is that wherein any thing is put; as a bag for pepper, a cheſt for ſugar, &c.

Queſtion 7. What is a Cheſt of *Sugar* worth, that waigheth neat waight (the *Tare* being ſubtracted) 7 ¼ C. 7 lb. at 6 l. 3 s. 4 d. the C ?

Facit 48 l. 3 s. 6 ½ d.

	l.	s.	d.
7 times 6 *pounds* make	42	00	00
7 times 3 *ſhillings* make	1	01	00
7 *groats* make	0	02	04
The halfe of 6 l. 3 s. 4 d. for ½ C. is	3	01	08
The halfe of 3 l. 1 s. 8 d. for ¼ C. is	1	10	10
The fourth part of 1 l. 10 s. 10 d. (becauſe 7 lb. make ¼ of 28 pounds or ¼ C.) is	0	07	08 ½
	48	03	06 ½

Rules of *Practice* in this kinde will bee the readier, if ſome few Notions in relation to *Engliſh Coines* be retained in memory, *viz.* ſuch as are expreſt in the ſubſequent *Table*.

20 *Groat*s

		l. s. d.	
20 *Groats*	make	0-06-8	or a *Noble.*
40 *Groats*		0-13-4	or a *Marke.*
60 *Groats*		1-00-0	a *pound Sterling.*
120 *Groats*		2-00-0	
180 *Groats*		3-00-0	
240 *Groats*		4-00-0	
300 *Groats*		5-00-0	
100 *Shillings*		5-00-0	
1000 *Shillings*		50-00-0	
60 *Pence*		0-05-0	A *Crown.*
120 *Pence*		0-10-0	An *Angell.*
240 *Pence*		1-00-0	

The benefit of the ſaid *Table* will bee partly manifeſt by the two ſubſequent *examples.*

Queſtion 8. At 7 d. the pound of *Currants*, what will 1 C. 8 lb. or 120 lb. amount unto ?

Facit 3 l. 10 s.

	l.	s.	d.
120 *Three-pences*, or 60 *six-pences*, or 30 *shillings* make	1	10	00
120 *Groats*, make	2	00	00
	3	10	00

Question 9. At 14 ½ d. the pound of *Sugar*, what will 1200 pounds amount unto?

Facit 72 l. 10s.

	l.	s.	d.
1200 *Shillings* make	60	00	00
1200 *Two-pences* or 600 *Groats* make	10	00	00
1200 *Halfe-pence*, or 600 *pence*, or 300 *two-pences*, or 150 *Groats* make	2	10	00
	72	10	00

Thus far a reasonable capacity may go, without multiplying or dividing, unlesse by doubling or halving, but such which can Multiply or Divide, may make more expedition as will be manifest by the subsequent *examples*.

Question

Question 10. In 1000 *Marks English*, how many pounds *Sterling*?

Facit 666 l. 13 s. 4 d.

For since 1000 *Marks* are equall unto 1000 *Nobles*, and three *Nobles* make a pound *Sterling*, therefore $\frac{1}{3}$ of 2000, *viz.* 2000 divided by 3, quoteth 666 $\frac{2}{3}$ l. that is 666 l 13 s. 4 d.

Question 11. At 14 s. 8 d. the pound of *Tobacco*, what will 573 pounds amount unto?

Facit 420 l. 4 s.

Since in 14 s. 8 d. (the price of 1 lb. waight) there is contained $\frac{1}{2}$ l. *Sterling*, $\frac{1}{3}$ l. also $\frac{1}{2}$ s. and $\frac{1}{6}$ s. therefore,

	l.	s.	d.
$\frac{1}{2}$ of 573 is 286 $\frac{1}{2}$ l. or —	286	10	00
$\frac{1}{3}$ of 573 is 114 $\frac{1}{3}$ l. or —	114	12	00
$\frac{1}{2}$ of 573 is 286 $\frac{1}{2}$ s. or —	14	06	06
$\frac{1}{6}$ of 573 is 95 $\frac{1}{2}$ s. or —	4	15	06
	420	04	00

Question 12. At 5 l. *per Centum*, what must be allowed for 8504. 18 s. 7 d?

Facit 42 l. 10 s. 11 $\frac{1}{20}$ d.

Observe

Obſerve the Operation in the *Margent*, and find firſt of all how much 5 times 850 l. 18 s. 7 d. will amount unto, in manner following, *viz.*, 5 times 7 pence make 2 s. 11 d. which 11 d. is to bee placed underneath the line as you ſee, and the 2 s. are to be reſerved in mind;

l.	l.	l.	s.	d.
100	— 5	— 850.	18.	7
				5
li.	42	54.	12.	11
		20		
s.	10	92		
		12		
		195		
		92		
d.	11	15	3	
		100	20	

Again, 5 times 18 ſhillings, make 90 s, which with 2 s, in minde make 4 l, 12 s, which 12 s, are to bee placed underneath the line as you ſee, and the 4 l, are to bee reſerved in mind; again multiplying 850 l, by 5, and unto the Product adding 4 l, in mind, the ſum will be 4254 l: ſo the totall Product is found to be 4254 l, 12 s, 11 d. which is to bee divided by 100 (the firſt Terme in the Rule) in this manner, *viz.* begin with the ſaid 4254 l, and divide the ſame by 100, which is performed by cutting off two places towards the right hand,

ſo

so will the Quotient bee 42 pound, and there will remaine 54 pound, which remainder being Multiplied by 20 shillings, and the 12 shillings standing in the place of shillings taken in to the Product, the aggregate will bee 1092 shillings, which being divided by 100, (in cutting off two places towards the right hand) the quotient will be tenne shillings, and there will remain 92 shillings, which remainder being multiplied by 12 pence, and the 11 d, standing in the place of pence taken into the Product, the aggregate will bee 1115 pence; which being divided by 100, in cutting off two places towards the right hand as before, the quotient will bee 11 $\frac{11}{100}$ d. that is, (the Fraction being abbreviated) 11 $\frac{1}{20}$ d. So the answer of the question is found as you see 42 l, 10 s, 11 $\frac{1}{20}$.

Question 13. At 6 l, 15 s, *per Centum*, what doth 2156 l, 13 s, 4 d. amount unto?

Facit 145 l, 11 s, 6 d.

After the manner of the last *Example*, Multiply the said 2156 l, 13 s, 4 d. by 6, and place the Product which

is

is 12940 underneath the line as you see, then since 15 s, are equall unto $\frac{1}{4}$ l. together with $\frac{1}{4}$ l, take therefore $\frac{1}{2}$ also $\frac{1}{4}$ of the said, l. 2156 l, 13 s, 4 d. and adde those quotients to the Product first found, then proceed with the aggregate, according to the twelfth *question*:

	l.	s.	d.
	2156.	13.	4
			6
	12940.	00.	0
	1078.	06.	8
	539.	03.	4
l. 145	57.	10.	0
	20		
s. 11	50		
	12		
	100		
	50		
d.	6	00	

So will you finde the answer of this question to be 145 l, 11 s, 6 d.

Question 14. At 8 pounds *per Centum, per An.* what doth 3546 l, 15 s, 6 d. amount unto for 10 moneths?

Facit 236 l, 9 s, $\frac{2}{5}$ d.

After the manner of the 12 *question*, Multiply the said 3546 l, 15 s, 6 d. by 8, and place the Product underneath the line as

as you see then since 10 months are equall unto $\frac{1}{2}$ yeare together with $\frac{1}{8}$ yeare, take therefore $\frac{1}{2}$ also $\frac{1}{3}$ of the aforesaid Product, and adde the said quotients together.

Lastly proceede with the aggregate, according to the directions in the twelfth *question*.

So will you finde the answer of this *question* to be 236 l, 9 s, $\frac{2}{5}$ d:

	l.	s.	d.
	3546.	15.	6
			8
	28374.	04.	0
	14187.	02.	0
	9458.	01.	4
li.	236	03.	4
		20	
s.	9	03	
		12	
	40	2	
	100	5	

CHAP.

Chap. II.

Of exchange of Coines, Waights and Measures.

THe *Rate* or *Proportion* between Coins, Waights and Measures of different kinds being knowne, either from some good Author, or rather by experience, it will be easie for such as understand the *Rule of Three*, to convert one *Species* into another according to the manner of Operation in the following *examples*.

See the Merchants Mapo of commerce.

Question 1. Unto how much *sterling* money do 1234 *Francs* or pounds *Tournois* amount at 2 s. *sterling* the pound *Tournois*? *Facit* 123 l. 8 s. *sterling*.

1 l. *Tourn.*—2 s. *Ster.*—1234 l. *Tourn.*
Facit 123 l. 8 s. *Sterling*.

Question 2. How many *Ryders* at 2 l. 1 s. 2 ½ d. *Sterling* the piece, ought to be received for 251 l. 6 s. 4 ½ d. *Sterling*?
Facit 237 *Ryders*.
1 l. 1 s. 2 ½ d. *Ster.*—1 *Ryder*—251 l. 6 s. 4 ½ d. *Sterling*. *Facit* 237.

Question

Question 3. How many *Quart d' Escus* ought to be received for 28 l. *sterling*, when 5 *Quart d' Escus* are 8 s. *sterling*? *Facit* 350.

8 ——— 5 ——— 560
1 ——— 5 ——— 70
Facit 350 *Qu. d' Escus*.

Question 4. How many *Spanish Pistolets* at 14 $\frac{3}{5}$ s. *sterling* the piece, ought to be received for 120 *Escus d' or* at 7 $\frac{1}{5}$ s. *sterling* the piece?

Facit 62 $\frac{12}{73}$ *Spanish Pistolets*.

This question and such like may be resolved by two single *Rules* of *Three*, as is manifest by the following operation.

I. 1 *Escus d' or* — 7 $\frac{1}{5}$ s. *sterling* — 120 *Escus d' or*.
Facit 45 l. 12 s. *sterling*.

II. 14 $\frac{3}{5}$ s. *ster.* — 1 *Span. pist.* — 45 l. 12 s. *sterling*.
Facit 62 $\frac{12}{73}$ *Spanish pistolets*.

Otherwise by one single *Rule* of *Three*, the termes being ordered as followeth; viz.

As the value of one piece of the Species sought,

sought, is to the number of pieces given to be reduced; so is the value of one piece of the Species given, to the value of one piece of the Species sought.

$14\frac{1}{3}$ s. *sterl.* — 120 *Escus d'or* — $7\frac{1}{3}$ s. *ster.*
73 — 120 — 38

Facit 62 $\frac{12}{73}$ *Spanish pistolets*, as before.

Question 5. If $\frac{1}{2}$ *Pistolet* of *Spain*, be valued at 3 l. 13 s. 6 d. *Tournois*; 6 l. *Tourn.* at 14 s. *Flemish*, and 18 l. 14 s. 7 d. *Flemish*, at 24 l. 12 s. 6 d. *sterling*, How many *Pistolets* ought I to receive for 72 l. 6 s. 9 d. *sterling*? *Facit* 98 $\frac{42}{49}$ *Pistolets*.

I. 3 l. 13 s. 6 d. *Tourn.* — $\frac{1}{2}$ *Pist.* — 6 l. *Tour.*

Facit $\frac{42}{49}$ *Pistol.* equall unto 14 s. *Flem.*

II. 14 s. *Flem.* — $\frac{42}{49}$ *Pist.* — 28 l. 14 s. 7 d. *Flemish.*

Facit 33 $\frac{74}{147}$ *Pistolets*, equall unto 24 l. 12 s. 6 d. *sterling.*

III. 24 l. 12 s. 6 d. *sterling*, — 33 $\frac{21}{147}$ *Pist.* — 72 l. 6 s. 9 d. *sterling.*

Facit 98 $\frac{42}{98}$ *Pistolets.*

Question 6. Unto how much (*Troy* waight) doo 5 C. 3 qu. 17 lb. (*Averdupois*

pois waight) amount, when the lb. *Averdupois* makes 1 lb. 2 Oun. 12 pen. *Troy*?

Facit 804 lb. 2 Oun. 12 pen.

1 lb. *Averdupois*, — 1 lb. 2 Oun. 12 p. *Troy* — 5 C. 3. qu. 17 lb. *Averdupois*.

Facit 804 lb. 2 Oun. 12 pen.

Question 7. How much waight at *Rouan* doe 365 lb. *Averdupois* make, when 100 lb. at *Rouan*, make 114 $\frac{1}{4}$ lb. *Averdupois*? *Facit* 319 $\frac{212}{457}$ lb. of *Rouan*.

114 $\frac{1}{4}$ — 100 — 365 — (319 $\frac{212}{457}$

Question 8. If 100 *Ells* of *Antwerpe* make 75 *yards* of *London*, how many *yards* of *London* measure, will $\frac{1}{4}$ 27 *ells* of *Antwerpe* make? *Facit* 20 *yards*.

100 — 75 — 27 — (20 $\frac{1}{4}$.

Question 9. How many *yards* of *London*, make 27 *ells* of *Antwerpe*, when 100 *ells* of *Antwerp* make 60 ells of *Lyons*, and 100 *ells* of *Lyons* make 25 *yards* of *London*?

ells Ly. *yards Lon.* *ells Ly.*

100 — 25 — 60

Facit 75 *yards* of *London*, equall unto 100 *ells* of *Antwerpe*.

Ells Antw. Yards Lond. ells Antw.
II. 100 —— 75 —— 27
Facit 20 $\frac{1}{4}$ *Yards of London.*

Question 10. How many *ells* of *Frankefort* make 42 $\frac{1}{4}$ *ells* of *Vienna* in *Austria*, when 35 *ells* of *Vienna* make 24 at *Lyons*; 3 *ells* of *Lyons*, 5 *ells* of *Antwerpe*; and 100 *ells* of *Antwerp*, 125 *ells* at *Frankefort*?
Facit 60 $\frac{1}{14}$ *ells of Frankefort.*

Ells Antw. ells Frank. ells Antw.
I. 100 —— 125 —— 5
Facit 6 $\frac{1}{4}$ *ells* of *Frankefort*, which are equall to 3 *ells* of *Lyons.*

Ells Ly. ells Fran. ells Ly.
II. 3 —— 6 $\frac{1}{4}$ —— 24
Facit 50 *ells* of *Frankefort*, which are equall unto 35 *ells* of *Vienna.*

Ells Vien. ells Fran. ells Vien.
III. 35 —— 50 —— 42 $\frac{1}{4}$
Facit 60 $\frac{1}{14}$ *ells* of *Frankefort.*

Such which have much practice in *exchanges*, and know what *proportion* the *Coines*, *Waights* and *Measures* of any *Countrey* or *City* doe beare unto those of another,

another, may by the *Rule* of *Three*, frame *Tables* for their owne uſe, therein expreſſing the *proportions* in ſuch manner, that the firſt Terme or *Antecedent*, of each *proportion*, may bee 1 or unity, and the *conſequent* or ſecond terme a *Decimall*, or elſe a mixt number, whoſe Fractionall part may be a *Decimall*, for then the *Coine*, *Waight*, &c. of the one place, (whoſe terme is 1) may bee reduced into that of the other place, by help of thoſe *Tables* and of *Multiplication* of *Decimalls* without ſenſible error: For *example*, It hath beene obſerved by ſome ingenious *Merchants*, that 100 lb. of *Averdupois* waight at *London*, are equall unto 89 lb. in *Paris* by the *Kings beam*, and conſequently 1 lb. *Averd.* is equall to $\frac{89}{100}$ lb. or .89 lb. at *Paris*, (for if 100 give 89, then 1 will give .89) therefore any number of pounds *Averdupois* being multiplied by .89 (with reſpect unto *Multiplication* of *Decimalls*, explained in the fifteenth Chapter of the preceding Book) will produce pounds of *Paris*: Again, if 89 lb. of *Paris* bee equall to 100 lb. *Averdupois*, then 1 lb. of *Paris* will bee equall to 1.1235 lb. of *Averdupois*; therefore any number of pounds of *Paris* being multiplied by

1.1235 will produce pounds *Averdupois*.

Vpon this ground I have collected the proportions in the ſubſequent *Tables*, wherein I would not have any to confide further then they ſhall know them to be agreeable to truth, for I have onely derived them from thoſe delivered by Maſter *Lewes Roberts Merchant*, in his *Map of Commerce*, and doe herein onely aime at the inſtruction of ingenious *Merchants* and *Factors* in the brieſeſt ways of calculating their *exchanges*, the *rate* or *proportion* being truely knowne; in which practice, *Decimall Arithmetique* (which hath no enemy but the Ignorant) will be very ſerviceable.

A Table

A Table for the Reduction of Averdupois *waight at* London, *to the waights of divers forreign Cities and remarkable places.*

One pound of *Averdupois* waight at *London*, makes at

	lb.
Antwerpe,	.9615
Amsterdam.	.9
Abbeville,	.91
Ancona,	1.282
Avignon,	1.12
Burdeaux,	.91
Burgoyne,	.91
Bollonia,	1.25
Bridges,	.98
Callabria,	1.3698
Callais,	1.07
Constantinople,	.8474 *Loder;*
Deepe,	.91
Dansicke,	1.16
Ferrara,	1.3333
Florence,	1.282
Flanders in general	1.06
Geneva,	.9345

One pound of *Averdupois* waight at *London*, makes at

	lb.	
Genoa,	1.4084	*ſuttle*
	1.4285	*groſſe*,
Hamburg	.92	
Holland,	.95	
Lixborne,	.881	
Lyons,	1.07	cõmon w.
	.98	ſilke w.
	.9	cuſtõers w.
Leghorn,	1.3333	
Millan,	1.4285	
Mirandola,	1.3333	
Norimberg	.88	
Naples,	1.4084	
Paris,	.89	
Prague,	.83	
Placentia,	1.3888	
Rotchell,	1.12	
Rome,	1.27	
Rouan,	.875	by vicõe
	.9017	com. w
Sivill,	1.08	
Tholouſa,	1.12	
Turin,	1.2195	
Venetia,	1.5625	ſuttle
	.9433	groſſe
Vienna,	.813	

The

The use of the preceding *Table* will be manifest by the subsequent *example*.

Question 11. How much waight at *Dansick* doe 320 lb. *Averdupois* make? *Facit* 371.2 lb. Seeke in the precedent *Table* for *Dansick*, and right against it you shall finde 1.16 which shewes that 1 lb. *Averdupois* is equall to 1 .16 lb. at *Dansick*, therefore multiply 320 by 1.16, so will the Product be 371.2 lb. of *Dansick* as by the Operation is manifest.

If 1 lb. *Aver.* 1 .16 lb. *Dans.* 320 lb. *Aver.*

1.16

1920
320
320

371|20

A Table for the Reduction of the waights of divers forreigne Cities and remarkable places to Averdupois *waight at* London.

One pound waight in	makes at *London* of *Averdupois* waight lb.
Antwerpe	1.04
Amsterdam	1.1111
Abbeville	1.0989
Ancona	.78
Avignon	.8928
Burdeaux	1.0989
Burgoyne	1.0989
Bollonia	.8
Bridges	1.0204
Calabria	.73
Calfais	.9345
Deepe	1.0989
Dansick	.862
Ferrara	.75
Florence	.78
Flanders in generall,	.9433
Geneva	1.07
Genoa suttle,	.71
Genoa grosse:	.7

Ham-

One pound waight in makes at *London* of *Averdupois* waight

	lb.
Hamburg	1.0865
Holland	1.0526
Lixbone	1.135
Lyons cõmon wt.	.9345
Lyons silke wt.	1.0204
Lyons custom wt.	1.1111
Leghorne	.75
Millan	.7
Mirandola	.75
Norimberg	1.1363
Naples	.71
Paris	1.1235
Prague	1.2048
Placentia	.72
Retchell	.8928
Rome	.7874
Rouan by Vicont,	1.1428
Rouan cõmon wt.	1.1089
Sivill	.9259
Tholousa	.8928
Turin	.82
Venetia suttle,	.64
Venetia grosse:	1.06
Vienna	1.23

The

The use of the last mentioned *Table*, will be maniteſt by this *example*, viz.

Queſtion 12. In 224 lb. waight at *Hamburg*, how many pounds *Averdupois*?

Facit 243. 376 lb.

Seek in the *Table* for *Hamburg*, and right againſt it you will finde 1 .0865 which ſheweth that 1 lb. of *Hamburg*, makes 1. 0865 lb. of *Averdupois*; therefore if 1 .0865 bee multiplied by 224 the Product will be pounds *Averdupois*.

1 —— 1 . 0865 —— 224

224

43460
21730
21730

243|3760

A Table

A Table for the Reduction of English ells to the Measures of diverſ forreigne Cities, and remarkable places.

One Ell at *London* makes at

Amſterdam	1.6949	Ells.
Antwerp	1.6666	
Bridges	1.64	
Arras	1.65	
Norimberg	1.74	
Colen	2.08	
Liſle	1.66	
Maſtrich	1.57	
Frankeford	2.0866	
Danſick	1.3833	
Vienna	1.45	
Paris	.95	Aulnes.
Roüan	1.03	
Lions	1.0166	
Callais	1.57	
Venice linnen.	1.8	Braces.
Venice ſilke	1.96	
Lucques	2.	
Florence	2.04	
Millan	2.3	
Leghorne	2.	
Madera	1.0328	
Iſles		

Sivill

One Ell at *London*, makes at			
	Sivill	1.35	
	Lisbone	1.	Vares
	Castilia	1.3875	
	Andoluzia	1.3625	
	Granado	1.3625	
	Genoa	4.8083	Palmes
	Saragosa	.55	Cants
	Rome	.56	
	Barselona	.7125	
	Valentia	1.2125	

The use of the aforesaid *Table* will be manifest by the subsequent *example*, *viz.*

Question 13. In 325 *ells* of *London*, how many *ells* at *Antwerpe*?

Facit 541.645 Ells: Seek in the *Table* for *Antwerp*, and right against it you shall find 1.6666 which being multiplied by 325 produceth 541.645 *ells* of *Antwerp*, as by the operation is manifest.

1 —— 1.6666 —— 325

325

83330
33332
49998

541|6450

A Table

A Table for the Reduction of the Measures of divers forreign Cities, and remarkable places to English *ells.*

One Ell at	*Amsterdam*	makes at *London*	.59
	Antwerp		.6
	Bridges		.6097
	Arras		.606
	Norimberg		.5747
	Colen		.4807
	Lisle		.6024
	Mastrich		.6369
	Frankeford		.4792
	Dansicke		.7228
	Vienna		.6896
One Aulin at	*Paris*		1.0528
	Roman		.9708
	Leons		.9836
	Callais		.6369
One Brace at	*venice* linnen		.5555
	venice silke:		.5102
	Lucques		.5
	Florence		.4901
	Millan		.4347
	Leghorn		.5
	Madera Isles		.9681

Ells

Sivill

One Vare at	*Sivill*	makes at *London*	.7407
	Lisbone		1.
	Castilia		.7207
	Andoluzia		.7339
	Granado		.7339
One Palm at	*Genoa*		.2079
One Cane at	*Saragosa*		1.8181
	Rome		1.7857
	Barselona		1.4035
	Valentia		.8247

Ells.

The use of the said *Table* will bee manifest by the subsequent *example*, viz.

Question 14. In 730 *Aulnes* at *Lions*, how many Ells at *London*?

Facit 718. 028. Seeke in the *Table* for *Lions*, and right against it you shall finde .9836 which being multiplied by 730 produceth 718. 028 Ells of *London*, as by the operation is manifest.

1 —— .9836 —— 730

730

295080

68852

718|0280

Upon

Upon the same ground, *Tables* for *exchange* of *coins* may be calculated by such which know the exact Rate, which in respect of the rising and falling of *Moneys* in divers places I have omitted.

Chap. III.

Of Interest of money.

I. *THe propositions or questions concerning Interest of money, consist of 4 termes*, viz. *Capitall* or *Principall*: *Time*; *the proportion which the principall bears to the Interest*; *and the Interest it selfe*: So if 100 l. be delivered to the end that 108 l. may be repayed at the end of a yeare, the said 100 l. is called *principall*; one yeare is the *time* of forbearance thereof; the *proportion* which the *principall* bears to the *Interest* is as 100 to 8; and the said 8 l. is the *Interest*.

II. *Interest is either Simple or Compound.*

III. *Simple Interest is that which arriseth or is computed from the principall only*: So if 100 l. be forborn two yeares, the *simple Interest* thereof after the rate of

8 pounds

8 pounds for 100 pounds for 1 yeare will be 16 pound, *viz.* 8 pound due at the firſt yeares end, and 8 pound due at the ſecond yeares end.

IV. *Compound Intereſt is that which ariſeth from the principall, and alſo from the Intereſt thereof, and therefore is called Intereſt upon Intereſt*: So if 100 pounds be forborn 3 yeares, and *compound Intereſt* thereof is to be computed after the rate of 8 pound *per centum, per annum*, there will ariſe beſides the *ſimple Intereſt* of the *principall* for 3 yeares, the *Intereſt* of 8 pound (due at the yeares end) for 2 yeares, and the intereſt of 8 pound (due at 2 yeares end) for 1 yeare.

V. *Rebate or diſcompt of money is, when a ſumme of money due at any time to come, is ſatisfied by the payment of ſo much preſent money, which being put forth at a certain rate of Intereſt for the ſaid time, would become equall to the ſumme firſt due*: So if 100 pound bee due at the end of two yeares, and is to be ſatisfied by the payment of preſent money upon rebate, after the rate of 8 pound *per centum, per annum, ſimple Intereſt*, there ought to be ſo much ready money paid, which in two yeares after the ſaid rate of Intereſt would be

bee augmented unto 100 pound. In like manner, if the rebate or discompt were to be made after any rate of *compound Interest*, so much ready money ought to be paid, which at the rate of *compound Interest* for the time agreed upon would become equall to the summe first due.

Questions of simple Interest.

Question 1. What is the *simple Interest* of 270 pound for one yeare after the rate of 8 l. for 100 l. for one yeare? See the Rules of Practice of this kind, in pag. 251.

Facit 21 l. 12 s.

If 100 —— 8 —— 270

Facit 21 $\frac{1}{3}$ l. or 21 l. 12 s.

Question 2. What is the *simple Interest* of 20 pounds for 3 yeares after the rate of 7 pound *per centum, per annum*?

Facit 4 $\frac{1}{5}$ l.

	y.	l.	y.	
I. If	1	7	3	*Facit* 21 l.
	l.	l.	l.	
II. If	100	21	20	*Facit* 4 $\frac{1}{5}$ l.

Question 3. What is the *simple Interest* of 235 l. for 5 moneths and 5 dayes, (accounting 28 dayes to each moneth) after

ter the rate of 6 l. *per centum, per annum*?
Facit $5\frac{412}{730}$ l.

	dayes.	*l.*	*dayes.*
I. If	365	— 6 —	145
or	73	— 6 —	29

Facit $\frac{174}{73}$ l.

	l.	l.	l.
II. If	100	— $\frac{174}{73}$ —	235

Facit $5\frac{412}{730}$ l.

Queſtion 4. If an Annuity of yearly rent of 20 pounds bee forborn 4 yeares, what will it amount unto at the end of the ſaid terme, allowing *ſimple Intereſt* after the rate of 7 l. *per centum per annum*, for each yeares rent, from the time at which it is due, untill the end of the ſaid terme of 4 yeares?

It is evident by the queſtion, that there muſt bee computed the *Intereſt* of 20 l. (due at the firſt yeares end) for the three following yeares; alſo the *Intereſt* of 20 pound (due at the ſecond yeares end) for the two following yeares, and the *Intereſt* of 20 pound due at the third yeares end, for the yeare following, the ſumme of which *Intereſt* being added to the aggregate of the foure yeares rent, gives the

ſumme

ſumme due, at the end of foure yeares.

l, l, l.

If 100 —— 7 —— 20

Facit 11, $\frac{2}{5}$ the *Intereſt* of 20 l. for 1 yeare;
therefore 2 $\frac{4}{5}$ for 2 yeares,
4 $\frac{1}{5}$ for 3 yeares;
80 the ſum of the foure yeares rent:
88 $\frac{1}{5}$ the totall ſum due at the end of 4 years.

Queſtion 5. How much ready money will pay 100 pounds due at the end of a yeare, rebating after the rate of 8 pound *per centum, per annum, ſimple Intereſt?*

Facit 92 l, 11 s, 10 $\frac{6}{27}$ d.

Adde 100 pound to its Intereſt 8 pound, ſo is the ſumme 108 pound; then it is evident that 108 pound due after the end of a yeare is equivalent to 100 pound ready money, according to the ſaid rate of *Intereſt*; Therefore the proportion will be:

If 108 —— 100 —— 100

Facit 92 $\frac{16}{27}$ l.

For as 100 pound ready money will be augmented to 108 pound at the yeares

end, so $92\frac{16}{27}$ pound ready money, will become 100 pound at the years end.

Question 6. How much present money will pay 315 pound due at the end of three moneths and eleven dayes, accounting twenty eight dayes to a moneth, and rebating after the rate of 7 pound *per centum per annum, simple Interest?*

Facit $309\frac{2701}{7433}$ l.

The Interest of 100 pound for three moneths eleven dayes, will be found (after the manner of the third Question) to bee $1\frac{60}{73}$ pound, which added to 100 pound, gives $101\frac{60}{73}$. Then

As $101\frac{60}{73}$ — 100 — 315 —

Facit $309\frac{2701}{7433}$ l.

Question 7. How much present money is equivalent to an Annuity or Rent of 100 pounds *per annum*, to continue five yeares, discounting after the rate of 6 pound *per centum, per annum, simple Interest?*

Facit $425\frac{3281159}{8821267}$ l.

It is manifest that there must bee computed the present worth of 100 pound, due at the first yeares end; Also the present worth of 100 pound, due at the se-

cond

cond yeares end, and in like manner for the third, fourth, and fifth yeares; all which particular present worths being added together, will give the totall present worth of the Annuity, which may be performed in manner following, *viz.*

	l,	l,	l.
1	106 —	100 —	100 — (94 $\frac{18}{53}$
2	112 —	100 —	100 — (89 $\frac{2}{7}$
3	118 —	100 —	100 — (84 $\frac{44}{59}$
4	124 —	100 —	100 — (80 $\frac{20}{31}$
5	130 —	100 —	100 — (76 $\frac{12}{13}$

Facit 425 $\frac{3216150}{8821267}$ l.

From the manner of Resolution of the last mentioned question, that *Rule* commonly called *Æquation* of *Payment* found in divers *Treatises* of *Arithmetique*, will be found erroneous, for the manifestation whereof, I shall propound as followeth;

1. Since that *rule* aimes at the reducing of severall dayes of payment, upon which particular summes of money are due, unto a mean time, upon which the aggregate or totall of those particular summes ought to be paid, without dammage to the *Debitor* or *Creditor*, there must be necessarily some

A detection of the erroniousnesse of that Rule called *Æquation* of Payment, found in divers Treatises of Arithmetique, *viz.* in *Mastersons* Arithm. pag. 153. *Records* Arithmetique, pag. 493. *Johnsons* Arithmetique, pag. 208. and divers others.

rate of *Intereſt* implyed: otherwiſe, why may not any day at pleaſure bee aſſigned for one intire payment.

2. If ſome *rate* of *Intereſt* be implied, then equity requires, that the preſent worth of the totall ſumme payable at one intire payment, *rebate* or *diſcompt* being made according to that *rate* of *Intereſt*, may bee equall to the aggregate or ſumme of the preſent worths of the particular ſummes of money, *rebate* being made according to their reſpective times, at the ſame *rate* of *Intereſt*.

3. In regard the ſaid *Rule* doth mention no *particular Rate* of *Intereſt*, it ought to be true according to *any Rate* of *Intereſt*.

4. Let us therefore examine the ſaid *rule* according to the *rate* of 6 *per centum*, *per annum*, *ſimple Intereſt*, taking the laſt mentioned queſtion for *example*, which (according to the accuſtomed manner) will bee thus ſtated, *viz.* If 500 pound ought to bee paid in 5 yeares by equall payments (that is to ſay) 100 pound at each yeares end, what time ought to bee given for the payment of the ſaid 500 l. at one intire payment, without loſſe either to the *Debitor* or *Creditor*?

5 Pro-

5. Proceeding according to the ſaid *rule* of *Æquation of payments* (which ſaith, *As the ſumme or aggregate of the particular ſummes of money is to the ſum or aggregate of the Products ariſing from the Multiplication of each particular ſum of mony by its reſpective time, ſo is 1 or unity to the mean time to be aſſigned for one intire payment*,) there will bee found three yeares, which time (according to the ſaid *rule*) ought to bee given for the payment of the whole 500 l.

6. The preſent worth of 500 pound due at the end of three yeares to come, *rebate* or *diſcompt* being made according to the *rate* of 6 *per centum, per annum, ſimple Intereſt* will be found (after the manner of the ſixth queſtion) to be 423 $\frac{42}{59}$ l. or 423 l, 14 s, 6 d, 3 farthings *proximè*; But (as is manifeſt by the reſolution of the laſt mentioned queſtion) the true preſent worth of 500 pound payable in 5 ſeverall yeares, *rebate* being made according to the ſaid *rate* of *Intereſt* is 425 $\frac{2286150}{3821267}$ l. or 425 l, 18 s, 9 $\frac{1}{2}$ d. *fere*; and therefore the Creditor loſeth 2 l, 4 s, 2 $\frac{1}{4}$ d. *proximè* in receiving the whole 500 pound, at three yeares end: Moreover at 6 *per centum, per annum, compound Intereſt*,

bee would lose 1 l. 8 s. 6 d. *ferè*, as will bee manifest by the *Tables* of *compound Interest* hereafter expressed: So that the losse will bee either more or lesse; according as the *Rate* of *Interest* doth differ: And therefore I conclude the said *rule*; (As also whatsoever other *rules* or *resolutions* of Questions which have dependence thereon) to bee erroneous: But to returne to our purpose.

The fifth, sixth and seventh precedent Questions, may bee a foundation for the calculating of *Tables* of *Rebate* for any *rate* of *simple Interest*, and Time propounded, by which *Tables*, and by the help of *Multiplication*, questions concerning *Rebate* or *Discompt* of money according to *simple Interest* may be resolved without sensible error.

A Table

Years	*A Table for discompt of money for any number of years under 8. at 8 l. per centum, per annum, simple Interest.*	Years	*A Table for discompt of Annuities for any nũber of years under 8, at 8 l. per centum, per annum, simple Interest.*
1	.925925925	1	.925925925
2	.862068965	2	1.787994890
3	.806451612	3	2.594446502
4	.757575757	4	3.352022259
5	.714285714	5	4.066307973
6	.675675675	6	4.741983648
7	.641025641	7	5.383009289

The Numbers in the first *Table* on the left hand are *Decimalls*, one pound *Sterling* being the *Integer*, and are thus found, *viz.*

As 108--100--1--(.925925925 &c.
126--100--1--(.862068965, &c.
124--100--1--(.757575757, &c.

Whereby

Whereby it appears, that one pound due at the end of a yeare is worth in ready money .925925, &c. that is, 18 s, 6 d. *ferè*. Alſo one pound due at the end of two yeares is worth in ready money .862068, &c. that is, 17 s, 3 d. *ferè* (as will appeare by the nineteenth rule of the twelfth Chapter aforegoing) and ſo of the reſt.

The uſe of the ſaid *Table* will bee maſeſt by the following *example*:

Queſtion 8. How much ready money will pay 345 l, 15 s, 6 d. due at the end of five yeares, *rebating ſimple Intereſt*, after the rate of 8 pound *per centum*, *per annum*?

Facit 246 l, 19 s, 7 ½ d.

In the aforeſaid *Table* for *Diſcompt* of *Money*, right againſt 5 yeares is the *Decimall* .714285, &c. being the ready money equivalent unto one pound due at the end of 5 yeares; Then (the 15 s, 6 d. in the Queſtion being reduced to a *Decimall* by the *Table* of *reduction* in page 87 of the preceding Booke) the proportion will be

1 —— .714285 —— 345.775

Facit 246.9818, &c.

That

That is, the *Decimall* being reduced according to the 19 rule of the 12 Chapter aforegoing 246 l, 19 s, 7 d. 2 f. *fere*.

Upon the ſame ground numbers might be calculated for moneths or dayes.

The numbers in the ſecond *Table* are found by the Addition of thoſe in the firſt; *viz.* the firſt number in the latter *Table* is the ſame with the firſt in the former, the ſecond in the latter is the ſumme of the firſt and ſecond in the former; the third in the latter is the ſum of the firſt, ſecond, and third in the former, &c. (the reaſon of which operation will bee manifeſt by the ſeventh Queſtion of this Chapter) whereby it appeares that one pound Annuity for two yeares is worth in ready money 1 .787994, l. &c. *rebating* after the rate of 8 l. *per centum, per annum, ſimple Intereſt:* Alſo one pound Annuitie for ſeven yeares is worth in ready money 5 l. 383009, &c. and ſo of the reſt.

The uſe of the ſaid *Table* will be manifeſt by the following

Example.

Queſtion 9. How much preſent money is equivalent to an Annuitie of 50 l.

per

per annum for five yeares, *discompting* after the rate of 8 l. *per centum, per annum, simple Interest?*

Facit 203 l. 6 s. 3 ¼ d.

In the second *Table* right against five yeares is 4.066307, &c. being the present worth of an Annuitie of one pound for five yeares, *discompting* after the *rate* of 8 pound *per centum, per annum*; Therefore it will be

If 1 — 4.066307 — 50
Facit 203.3153, &c.

That is, 203 l, 06 s, 03 d, 3 f. *fere.*

Of the forbearance of money at Compound Interest, or Interest upon Interest.

Question 10. If 425 pounds bee forborn or respited untill the end of foure yeares, what will it then bee augmented unto after the rate of 8 l. *per centum, per annum, compound Interest?*

Facit 578 l. 207808.

To resolve this and such like questions, there must bee found numbers in continuall proportion increasing as 100 to 108, (or as 100 to 107 if the rate of Interest were

were 7 *per centum, per annum,* and the like of others *mutatis mutandis*) which may be performed according to the following operation.

l.	l.	*yeares*
100-108-425	(459 at the end of	1
100-108-459	(495.72	2
100-108-495.72	(535.3776	3
100-108-535.3776	(578.207808	4

Upon this ground there may bee calculated *Tables* of *forbearance* of one pound principall, at any rate of *Compound Interest*, and for any terme of yeares propounded, by which *Tables*, and by the help of *Multiplication*, questions concerning the *forbearance* of *money* at *Compound Interest* may bee resolved without sensible error.

A Table

A Table shewing what 1 *l. will amount unto being forborn any number of yeares under* 31, *accounting compound Interest at* 8, 7, *and* 6, *per Centum, per Annum.*

Years	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
1	1.08	1.07	1.06
2	1.1664	1.1449	1.1236
3	1.25971	1.22504	1.19101
4	1.36048	1.31079	1.26247
5	1.46932	1.40255	1.33822
6	1.58687	1.50073	1.41851
7	1.71382	1.60578	1.50363
8	1.85093	1.71818	1.59384
9	1.99900	1.83845	1.68947
10	2.15892	1.96715	1.79084
11	2.33163	2.10485	1.89829
12	2.51817	2.25219	2.01219
13	2.71962	2.40984	2.13292
14	2.93719	2.57853	2.26090
15	3.17216	2.75903	2.39655

Ye.	8 per Cent.	7 per Cent.	6 per Cent.
16	3.42594	2.95216	2.54035
17	3.70001	3.15881	2.69277
18	3.99601	3.37993	2.85433
19	4.31570	3.61652	3.02559
20	4.66095	3.86968	3.20713
21	5.03383	4.14056	3.39956
22	5.43654	4.43040	3.60353
23	5.87146	4.74053	3.81975
24	6.34118	5.07236	4.04893
25	6.84847	5.42743	4.29187
26	7.39635	5.80735	4.54938
27	7.98806	6.21386	4.82234
28	8.62710	6.64883	5.11168
29	9.31727	7.11425	5.41838
30	10.06265	7.61225	5.74349

The Numbers in the first Columne on the left hand of the preceding *Table* signifie yeares: The numbers in the second Columne are calculated at the rate of 8 *per centum, per annum, compound Interest*, for 1 l. principall according to the following operation, *viz.*

As

As 100 is to-108 so is-1 to——1.08
100——108——1.08——1.1664
100——108——1,1664-1.259712

The numbers in the third Columne are calculated at the rate of 7 *per centum per annum compound Interest* for one pound principall in the same manner as before, *viz.*

As 100 is to-107 so is-1 to——1.07
100——107——1.07——1.1449
100——107——1.1449-1.225043

The numbers in the fourth Columne are calculated at the rate of 6 *per centum, per annum, compound Interest* for one pound principall, in the same manner as the former (*mutatis mutandis.*)

The use of the said Table will be manifest by the two following Questions.

Question 11. If 225 l. 10 s. be forborn untill the end of 9 yeares, what will it then amount unto after the rate of 8 *per centum per annum, Compound Interest?*

Facit 450 l. 14 s. 5 d. 3 f. *fere.*

In the second Columne right against 9 yeares

yeares is 1.999 which shewes that one pound being forborn 9 yeares, will bee augmented unto 1. 999 at the rate of 8 *per centum, per annum, compound Interest*; therefore (the 10 s. in the question being reduced into a Decimall) it will be

If 1 —— 1.999 —— 225.5

Facit 450.7745 that is (the *Decimall* being reduced according to the nineteenth Rule of the twelfth Chapter) 450 l. 15 s. 5 d. 3 f.

Question 12. What will 136 l. 13 s. 6 d. amount unto, being forborn 20 yeares after the rate of 6 *per centum, per annum, compound Interest*?

Facit 438 l. 13 s. $1\frac{1}{4}$ d.

In the fourth Columne right against 20 yeares is 3.20713, which shewes that one pound being forborn 20 yeares will bee augmented unto 3. 20713; therefore (the 13 s. 6 d. in the question being reduced into a *Decimall* by the *Table* of *Reduction*, in the 12 Chapter it will be

If 1 —— 3.20713 —— 136.775

Facit 438.655, &c. that is 438 l. 13 s. 1 d. 1 f. *fere*.

In the same manner, the numbers in the

third Columne, are to bee used.

Of the forbearance of Annuities, Rents or Pensions payable yearly, accounting Compound Interest.

Question 13. If an *annuitie* of 425 l. payable yearly be in Arrere for 4 yeares, unto what summe will it then amount accounting after the rate of 8 *per centum, per annum, compound interest*; for each particular *annuitie* from the time at which it grew due, untill the end of the said terme of 4 yeares?

Facit 1915 l. 1 s. 11. $\frac{1}{2}$ d. *proximè.*

It is evident by the question, that if there be computed what 425 l. due at the years end will amount unto, being put forth at the said rate of *compound Interest* for the 3 following yeares; Also what 425 l. due at the second yeares end will be augmented unto in the two following yeares, and what 425 l. due at the third yeares end will bee augmented unto at the end of the following yeare; Lastly, if the said particular summes so found be added to 425 l. (the last yeares rent) the summe will be the totall rent in Arrere at the foure yeares end; *viz.*

According

According to the manner of the 10. queſtion, 425 l. in 2 yeares after the rate of 8 li. *per cent. per ann. compound Interest* will be augmented into	535.3776
In like manner, 425 li. in two yeares, will become	495.72
Alſo 525 li. at the yeares end, will become	459
The laſt yeares *Annuitie* is	425
The ſum due at 4 yeares end,	1915.0976

Otherwiſe,

Find a *principall* which may bee in the ſame proportion to 425 as 100 is 108, and ſay

As 108 — 100 — 425 *Facit* 5312.5

Then find what 5312.5 will amount unto being forborn 4 yeares after the rate of 8 *per cent. per ann. compound Interest* (according to the 10. Queſtion) which will be 7227.5976 from which ſubtracting the *principall* 5312.5 the remainder (as before) is 1915.0976 being the ſumme which 425 l. *annuity* will bee augmented unto at the end of 4 yeares, according to

the ſaid rate of *Intereſt*, the *annuitie* being payable yearly.

Upon either of the aforeſaid grounds; *Tables* of the forbearance of one pound Annuitie at any rate of *compound Intereſt*, and for any terme of yeares, may bee calculated; or they may be compoſed by the addition of the numbers in the *Table* in page 288 *viz.* the firſt number in each of the Columnes in the ſubſequent *Table* is 1 or unity; the ſecond number in each (the Columne of yeares excepted) is compoſed of 1 or unitie, and the firſt number in the reſpective Columnes in the *Table* in page 288 Alſo the third number in each of theſe is compoſed of 1, and the ſumme of the 1 and 2 numbers in each of thoſe reſpectively, &c. But you are to obſerve that according to the laſt mentioned way of compoſition of the ſubſequent *Table*, the numbers in the *Table* in pag. 288 ought to be continued to more places then are there expreſt, to prevent error which may happen by reaſon of many Additions.

Table

A Table ſhewing what 1 pound Annuity being forborn any number of yeares under 31 will amount unto at 8, 7, and 6, per Cent. per Ann. Compound Intereſt, the ſaid Annuitie growing due at yearly payments

Yeares	8 per Cent.	7 per Cent.	6 per Cent.
1	1.00000	1.00000	1.00000
2	2.08000	2.07000	2.06000
3	3.24640	3.21490	3.18360
4	4.50611	4.43994	4.37461
5	5.86660	5.75073	5.63709
6	7.33592	7.15329	6.97531
7	8.92280	8.65402	8.39383
8	10.63662	10.25980	9.89746
9	12.48755	11.97798	11.49131
10	14.48656	13.81644	13.18079
11	16.64548	15.78359	14.97164
12	18.97712	17.88845	16.86994
13	21.49529	20.14064	18.88213
14	24.21492	22.55048	21.01506
15	27.15211	25.12902	23.27596

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	30.324284	27.888053	25.672528
17	33.750227	30.840217	28.212879
18	37.450245	33.999033	30.905653
19	41.446263	37.378965	33.759992
20	45.761964	40.995492	36.785591
21	50.422921	44.865177	39.992727
22	55.456755	49.005739	43.392290
23	60.893293	53.436141	46.995828
24	66.764759	58.176671	50.815577
25	73.105940	63.249038	54.864512
26	79.954415	68.676470	59.156383
27	87.350768	74.483823	63.705766
28	95.338831	80.697691	68.528112
29	103.96592	87.346529	73.639798
30	113.28321	94.460786	79.058186

The use of the preceding *Table*, will be manifest by the following *Question*.

Question

Queſtion 14. What will 20 l. *Annuitie* for 15 yeares payable yearly, be augmented unto being all unpaid or forborn untill the end of the ſaid terme, accounting *Compound Intereſt* at the rate of 8 *per Cent. per Ann.* ?

Facit 543 l. 0s. 10 $\frac{1}{4}$ d.

In the ſecond Columne right againſt 15 yeares is 27.15211 which ſhewes that 1 pound *Annuitie* for 15 yeares, will at the end of the ſaid terme accounting *compound Intereſt* after the rate of 8 *per cent. per ann.* amount unto 27 .15211. therefore it will be

If 1 —— 27.15211 —— 20

Facit 543.0422 that is, 543 l. 0s. 10 $\frac{1}{4}$ d.

In the ſame manner the numbers in the third and fourth Columnes are to be uſed.

Of Rebate or Diſcompt of money, according to Compound Intereſt.

Queſtion 15. If 8 pounds bee due at the end of 5 yeares, what is it worth in ready money, *diſcompting* after the rate of 8 *per cent. per ann. compound Intereſt* ?

Facit 5 $\frac{6382461}{14348907}$ l.

To resolve this and such like questions, there must be found numbers in continuall proportion decreasing, as 108 is to 100, (or as 107 is to 100 if the rate were at 7 *per cent.* &c.) which may be performed according to the following operation, *viz.*

		l.
1	As 108 — 100 — 8	— (7 $\frac{11}{27}$
2	108 — 100 — 7 $\frac{11}{27}$	— (6 $\frac{626}{729}$
3	108 — 100 — 6 $\frac{626}{729}$	— (6 $\frac{6902}{19683}$
4	108 — 100 — 6 $\frac{6902}{19683}$	— (5 $\frac{467721}{531441}$
5	108 — 100 — 5 $\frac{467721}{531441}$	— (5 $\frac{6382465}{14348907}$

Upon this ground, *Tables* of *Rebate* or *Discompt* may be calculated, according to *Compound Interest* for 1 pound *principall*, at any rate of *Interest*, and for any terme of yeares propounded, by which *Tables*, and by help of *Multiplication*, questions concerning *Discompt* or *Rebate* of *money* according to *compound Interest*, may be resolved without sensible error.

A Table.

A Table shewing what 1 *l. due at the end of any number of yeares to come under* 31, *is worth in ready money, discompting or rebating yearely after the rates of* 8, 7, *and* 6, *per Centum, per Annum, compound Interest.*

Years	8 per Cent.	7 per Cent.	6 per Cent.
1	.925925	.934579	.943396
2	.857338	.873438	.889996
3	.793832	.816297	.839619
4	.735029	.762895	.792093
5	.680583	.712986	.747258
6	.630169	.666342	.704960
7	.583490	.622749	.665057
8	.540268	.582009	.627412
9	.500248	.543933	.591898
10	.463193	.508349	.558394
11	.428882	.475092	.526787
12	.397113	.444012	.496989
13	.367697	.414964	.468839
14	.340461	.387817	.442300
15	.315241	.362446	.417265

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	.291890	.338734	.393646
17	.270268	.316574	.371364
18	.250249	.295864	.350343
19	.231712	.276508	.330512
20	.214548	.258419	.311804
21	.198655	.241513	.294155
22	.183940	.225713	.277505
23	.170315	.210947	.261797
24	.157699	.197146	.246978
25	.146017	.184249	.232998
26	.135201	.172195	.219810
27	.125186	.160930	.207367
28	.115913	.150402	.195630
29	.107327	.140563	.184556
30	.099377	.131367	.174110

The numbers in the first Columne of the preceding *Table* signifie yeares; the numbers in the second Columne are *Decimalls*, one pound being the *Integer*, and are calculated for the *rebate* or *discompt* of 1 pound *principall* after the rate

rate of 8 *per centum, per annum, compound Intereſt* according to the following Operation, *viz.*

As 108-100-1-($\frac{25}{27}$ or .925925, &c.
As 108-100-$\frac{25}{27}$ or.925925, &c.($\frac{625}{729}$ or.857338, &c.

The *Decimalls* in the third and fourth Columnes are found in the ſame manner (*mutatis mutandis.*) The uſe of the preceding *Table* will be manifeſt by the following *example.*

Queſtion 16. If 356 pounds be payable at the end of ſeven yeares, what is it worth in ready money *diſcompting* after the rate of 7 *per centum, per annum, compound Intereſt?*

Facit 221 l. 14 s. *ferè.*

In the third Columne right againſt ſeven yeares is .622749 being the ready money equivalent unto 1 l. due at the end of ſeven yeares, *rebating* after the *rate* of 7 *per centum, per annum, Compound Intereſt*; therefore.

If 1 ——→. 622749 ——356
Facit 221 .6986, &c. or 221 l. 14 s. *proximè.*

In the ſame manner the numbers in the 2d. and 4th. Columnes are to be uſed.

Of

Of the present worth of Annuities, Rents, or Pensions, payable at yearly payments.

Question 17. What is the present worth of an *Annuitie* of 8 pounds to continue 4 yeares, *discompting* after the *rate* of 8 *per centum*, *per annum*, *Compound Interest?*

Facit 26 $\frac{1023309234415 26}{2058911320946 49}$ lb.

It is evident by the *question* that there must be computed (according to the manner of the 15th. *question*) the present worth of 8 pound due at the first yeares end: Also the present worth of 8 pound due at the second yeares end; and in like manner for the third and fourth yeares, which particular present values of each yeares *Annuitie* being added together, give the present value of the *Annuitie* propounded, *viz.*

8 Pounds payable at the end of one yeare, is worth in ready money (as will bee manifest by the 15th. *question*:) —— 7 l. $\frac{11}{27}$

8 Pounds

8 Pounds payable at the end of two yeares, is worth in ready money — 6 l. $\frac{626}{729}$

8 Pounds payable at 3 yeares end, is worth in preſent money — $6\frac{4924}{19683}$

8 Pounds payable at 4 yeares end, is worth in preſent money — $5\frac{467785}{531441}$

The preſent worth of 8 pounds *Annuitie* for 4 yeares — $26\frac{10231092144136}{20589113294649}$ l.

Upon this ground, *Tables* may be calculated to ſhew the preſent worth of 1 l. *Annuitie* for any terme of yeares, and at any *rate* of *compound Intereſt* propounded, or they may be compoſed more eaſily by the Addition of the numbers in the *Table*, in page 299 By which *Tables*, and by the help of *Multiplication*, queſtions concerning the preſent worth of *Annuities*, may be reſolved without ſenſible error.

A Table.

A Table shewing the present worth of 1 pound Annuitie to continue any Terme of yeares under 31, and payable yearely, after the rate of 8, 7, and 6, per Centum, per Annum, Compound Interest.

Years	8 per Cent.	7 per Cent.	6 per Cent.
1	.92592	.93457	.94339
2	1.78326	1.80801	1.83339
3	2.57709	2.62431	2.67301
4	3.31212	3.38721	3.46510
5	3.99271	4.10019	4.21236
6	4.62287	4.76653	4.91732
7	5.20637	5.38928	5.58238
8	5.74663	5.97129	6.20979
9	6.24688	6.51523	6.80169
10	6.71008	7.02358	7.36008
11	7.13896	7.49867	7.88687
12	7.53607	7.94268	8.38384
13	7.90377	8.35765	8.85268
14	8.24423	8.74546	9.29498
15	8.55947	9.10791	9.71224

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	8.85136	9.44664	10.10589
17	9.12163	9.76322	10.47725
18	9.37188	10.05908	10.82760
19	9.60359	10.33559	11.15811
20	9.81814	10.59401	11.46992
21	10.01680	10.83552	11.76407
22	10.20074	11.06124	12.04158
23	10.37105	11.27218	12.30337
24	10.52875	11.46933	12.55035
25	10.67477	11.65358	12.78335
26	10.80997	11.82577	13.00316
27	10.93516	11.98671	13.21053
28	11.05107	12.13711	13.40616
29	11.15840	12.27767	13.59071
30	11.25778	12.40904	13.76482

The first number in the second, third, and fourth Columnes of the preceding *Table* is the same with the first in the second, third, and fourth Columnes respectively of the *Table* in page 299 the second in each of these is the summe of

of the firſt and ſecond in each of thoſe reſpectively, the third in theſe is the ſumme of the firſt, ſecond, and third in thoſe reſpectively; But here you are to obſerve that according to the laſt mentioned way of compoſition of the preceding *Table*, the numbers in the *Table* in page 299 muſt be continued to more places then are there expreſt, to avoid error which may happen by reaſon of many Additions.

The uſe of the preceding *Table* will be manifeſt by the ſubſequent *example*.

Queſtion 18. What is the preſent worth of an *Annuitie* or *Rent* of 50 pounds *per annum*, payable yearly for 21 yeares, accounting *compound Intereſt* after the rate of 6 *per cent. per annum*?

Facit 588 l. 4 s. $\frac{1}{4}$ d. *fere*.

In the fourth Columne right againſt 21 yeares is 11.76407 being the preſent value of one pound *Annuitie* for 21 yeares at the ſaid rate of *compound Intereſt*, therefore

If 1 —— 11.76407 —— 50

Facit 588.2035 or 588 l. 4 s. $\frac{1}{4}$ d.

In the ſame manner the numbers in the ſecond and third Columnes are to be uſed.

Of

Of the purchase of Annuities, Rents or Pensions, (to continue any Terme of yeares, and at any rate of Compound Interest propounded.)

When a summe of money is propounded to finde what *Annuitie* (to continue any number of yeares, and according to any given rate) that summe will buy, presuppose at pleasure any *Annuitie* for the Terme propounded, and finde the value of that *Annuitie* in ready money (according to the manner of the seventeenth question) at the rate assigned; Then will the *proportion* be as followeth.

As the value found, is to the supposed Annuitie; so is the summe of money propounded, to the Annuitie required.

Question 19. What *Annuitie* to begin presently, and to continue 4 yeares, will 500 pounds deserve, accounting *compound Interest* at the rate of 8 *per centum, per annum?*

Facit 150 $\frac{65491411166545}{6819375447378}$ l.

Let the *suppositiall Annuitie* be 8 pound *per Annum*, to continue foure yeares,

whose value in ready money will be found (according to the manner of the 17th. *question*) to be 26 $\frac{102330923441526}{205891132094649}$ l.

Then say,

If 26 $\frac{102330923441526}{205891132094649}$ l. — 8 l. — 500 l.

Facit 150 $\frac{6549343366545}{6819375447378}$ l. or 150 l. 19 s. 2 d, 2 f. *fere.*

Upon this ground, *Tables* may be calculated to shew what *Annuitie* (to continue any terme of yeares and at any rate propounded) one pound will buy, by which *Tables*, and by the help of *Multiplication*, *questions* concerning the *purchase* of *Annuities*, *Rents*, or *Pensions*, may bee resolved without considerable error.

[A Table

A Table ſhewing what Annuitie payable at yearely payments, to continue any terme of yeares under 31, one pound will purchaſe, at the rates of 8, 7, & 6, per Centum, per Annum, Compound Intereſt.

Yeares	8 per Cent.	7 per Cent.	6 per Cent.
1	1.08000	1.07000	1.06000
2	.56076	.55309	.54363
3	.38803	.38105	.37411
4	.30192	.29519	.28859
5	.25045	.24389	.23739
6	.21631	.20979	.20336
7	.19207	.18555	.17913
8	.17401	.16746	.16103
9	.16007	.15348	.14702
10	.14902	.14237	.13586
11	.14007	.13335	.12679
12	.13269	.12590	.11927
13	.12652	.11965	.10296
14	.12129	.11434	.10758
15	.11682	.10979	.10296

Ye.	8 *per Cent.*	7 *per Cent.*	6 *per Cent.*
16	.11298	.10585	.09895
17	.10962	.10242	.09544
18	.10670	.09941	.09235
19	.10412	.09675	.08962
20	.10184	.09439	.08718
21	.09983	.09228	.08500
22	.09803	.09040	.08304
23	.09642	.08871	.08127
24	.09497	.08718	.07967
25	.09367	.08581	.07822
26	.09250	.08456	.07690
27	.09144	.08342	.07569
28	.09048	.08239	.07459
29	.08961	.08144	.07357
30	.08882	.08058	.07264

The invention of the Numbers in the second *Columne* of the preceding *Table*, is as followeth:

It

It is manifeſt by the tenth *queſtion*, and by the conſtruction of the *Table* in page 288, that one pound ready money is equivalent unto 1 $\frac{2}{25}$ l. or 1 .08 l. at the yeares end, at the rate of 8 *per centum, per annum*, which 1 .08 l. is the firſt number in the ſaid ſecond Columne: Again, the preſent value of one pound *Annuitie* for two yeares will bee found (according to the 17th. queſtion) to bee 1 $\frac{11417}{19683}$ l. or 1.78326474, &c. Therefore the proportion will be

If 1 $\frac{11417}{19683}$ l. or 1.78326474, &c. will purchaſe one pound *Annuitie* to continue two yeares, what *Annuitie* to continue the ſame terme will 1 pound ready money purchaſe? *Facit* $\frac{12681}{35100}$ l or .560769, &c. which is the ſecond number in the ſaid ſecond Columne of the preceding *Table*; from hence it is manifeſt that if unitie or 1 be divided by each number in the ſecond, third and fourth Columnes in the *Table* in page 304 the quotients will be the reſpective numbers of the ſecond, third and fourth Columnes in the preceding *Table*, in page 309, in which operation it will bee requiſite that the numbers of the ſaid *Table* in page 304 be continued to more places then are there expreſt.

The uſe of the precedent *Table* in page 309 will be manifeſt by the following *example.*

Queſtion 20. What *Annuity* to begin preſently and to continue 14 yeares, payable at yearely payments will 320 l. purchaſe, *compound Intereſt*, being reckoned at 6 *per centum, per annum?*

Facit 34 l. 8 s. 6 d. *fere.*

In the fourth Columne right againſt 14 yeares is .10758 which ſhewes that one pound ready money will purchaſe an *Annuitie* of .10758 l. to continue 14 yeares; at the ſaid rate of *compound Intereſt*, therefore it will be

If 1 ——.10758 ——320

Facit 34.4256, &c. or 34 l. 8 s 6 d. *fere.*

Queſtion 21. If 100 l. be put forth at *compound Intereſt* for two yeares, and at the end of the ſaid terme bee augmented unto 116 $\frac{16}{25}$ l. what is the rate of *Intereſt*, or what was the ſaid 100 l. augmented unto at the firſt yeares end?

Anſwer, The rate of *Intereſt* is 8 *per centum, per annum, viz.* the ſaid 100 l. was augmented unto 108 l. at the years end.

In this queſtion there are three numbers in *Geometricall proportion continued, viz.*

viz. 100 l. the principall; the ſumme unto which the ſaid principall will be augmented at the yeares end, which is unknown: And the ſumme unto which it is augmented at the ſecond yeares end, *viz.* $116\frac{16}{25}$, ſo that the ſcope of the queſtion is to finde a *Geometricall mean-proportionall*, (or the middle number of the aforeſaid 3 numbers) by knowing the two *extremes*, which is performed by this *Rule, viz.*

Two numbers being given to find a Geometricall mean proportionall.

Multiply the two extreme numbers one by the other, and extract the ſquare-roote of the Product, which ſquare-roote is the mean proportionall ſought: So if the two *extremes* 100 and $116\frac{16}{25}$ bee multiplied together, the Product will bee 11664 whoſe *ſquare-roote* is 108 for the *mean-proportionall* ſought, which ſhewes that the principall 100 l. was augmented unto 108 l. at the yeares end, and therefore the rate of *Intereſt* is 8 *per centum, per annum.*

In the ſame manner you may finde the true *proportionall Intereſt* of 100 l. for $\frac{1}{2}$ yeare, according to the rate of 8 *per centum, per annum*, which ought not to be 4 l. (for he that receives 4 l. for 100 l. for $\frac{1}{2}$ yeare, may at the ſame rate of *Intereſt* put forth the ſaid 4 l. for the following

lowing ½ yeare, and ſo at the yeares end receive 108l. 3 s. $2\frac{40}{73}$ d. which exceeds the rate of 8 *per centum, per annum*) but the ſumme which 100l. will be augmented unto at the halfe yeares end is a *Geometricall mean-proportionall* between 100 and 108 which according to the former rule will bee found √10800 or 103.923048, &c. that is (the *Decimall* being reduced according to the 19th. *Rule* of the 12th. *Chapter*) 103l. 18s. $5\frac{1}{4}$d. *proxime.*

The way to calculate Tables for half yearly payments.

Upon this ground, *Tables* for halfe yearely payments may be calculated at the rate of 8 *per centum, per annum, compound Intereſt*, in the ſame manner as thoſe in pa. 288, 295, 299, 304, 309. uſing the numbers 100, 103.923048, &c in ſtead of the numbers 100, 108. and the like may be done for any other rate of Intereſt (*mutatis mutandis*) which I leave to the practice of the Ingenious *Arithmetician.*

Queſtion 22. If 100l. be put forth at *compound Intereſt* for 3 yeares, and at the end of the ſaid terme be augmented unto 125. 9712 l. what was it augmented unto at the firſt yeares end?

Facit 108l.

Here obſerve, that the Principall 100l. the

the ſummes unknown due at the ends of the firſt and ſecond yeares, and the ſumme unto which the Principall is augmented at the end of the third yeare, are foure numbers in *Geometricall proportion continued*, ſo that the tenour of the queſtion is to find the firſt of the two *mean-proportionalls* by knowing the two extremes, which is performed by this *rule, viz.*

To finde the firſt of two mean proportionalls between 2 extremes given.

Multiply the ſquare of the leſſer extreme by the greater, and extract the Cube roote of the Product, which Cube roote is the firſt of the two mean-proportionalls required: So if 100 l. (the leſſer extreme) be ſquared, it is 10000, which multiplied by 125.9712 (the greater extreme) produceth 1259712, whoſe *Cube roote* is 108 the firſt of the *mean-proportionalls* required, beeing the ſumme unto which the Principall will bee augmented at the yeares end.

Queſtion 23. What will 100 l. be augmented unto at the end of $\frac{1}{4}$ of a yeare after the rate of 8 *per centum, per annum?*

Facit 101 l. 18 s. 10 d. *proxime.*

In this queſtion there are 5 numbers in *Geometricall proportion continued, viz.* the Principall 100 l. the ſummes due at the end of the firſt, ſecond and third quarters

ters of the yeare, and 108 due at the yeares end, ſo that the tenour of the queſtion is to find the firſt of 3 *mean-proportionalls* between 100 and 108, which is performed by the following *rule, viz.*

To find the firſt of three mean proportionals between two extremes given.

Multiply the Cube of the leſſer extreme by the greater, and extract the Biquadrate roote of the Product, which Biquadrate roote is the firſt of the three mean-proportionalls required: So if 100 bee multiplied Cubically, the Product is 1000000, which being multiplied by 108, the Product is 108000000, whoſe *Biquadrate roote* will be found (according to the 30th. *Rule* of the 18th. *Chapter*) 101.94265, &c. or 101 l. 18 s. 10 d. *proxime.*

Upon the aforeſaid ground, *Tables* for quarterly payments may be calculated, at the rate of 8 *per centum per annum compound Intereſt* in the ſame manner as thoſe in pages 288, 295, 299, 304, 309. uſing the numbers 100, 101.94265, &c. in ſtead of the numbers 100, 108, and the like may be done for any other rate of *Intereſt* (*mutatis mutandis.*)

Queſtion 24. If the *Leaſe* of a houſe or lands be worth 153 l. *Fine*, and 16 l. *Rent per annum*, payable yearely for 21 yeares,

yeares, and the *Leſſee* be deſirous to bring down the *Fine* to 50 l. and, ſo to pay the more *Rent*, the queſtion is what *rent* the Tenant ſhall pay, accompting *compound Intereſt* at the rate of 8 *per centum*, *per annum* ?

Facit 26 l. 5 s. $7\frac{1}{4}$ d.

Finde the difference between the *Fines* which is 103 l. Then by the *Table* in page 309 finde what *Annuitie* or *Rent* to continue 21 yeares, is equivalent unto 103 l. ready money, ſo will you find 101. 5 s. $7\frac{1}{4}$ d. which being added to the old rent 16 l. gives 26 l. 5 s. $7\frac{1}{4}$ d. which the *Tenant* muſt pay to the end that the *Fine* may be diminiſhed unto 50 l.

Queſtion 25. There is a *Leaſe* of certain Lands to be let for 14 yeares for 250l. *Fine*, and 44 l. *Rent per annum*, payable yearely, but the *Tenant* is deſirous to pay leſſe *Rent*, *viz.* 20 pounds *per annum*, and to give a greater *Fine*; The queſtion is what *Fine* ought to be paid to bring down the *rent* to 20 l *per annum*, accompting *compound Intereſt* at the *rate* of 8 *per centum*, *per annum* ?

Facit 447 l. 17 s. $5\frac{1}{4}$ d.

Finde the difference between the *Rents* which will be 24 pounds *per annum*. Then by

by the *Table* in page 304, ſee what an *Annuitie* or *rent* of 24 l. *per annum*, to continue 14 yeares, is worth in ready money; ſo will you find 197 l. 17 s. 5 $\frac{1}{4}$ d. which being added to the firſt *Fine* 250 pounds, gives 447 l. 17 s. 5 $\frac{1}{4}$ d. which the *Tenant* muſt pay to the end the *rent* may be brought down to 20 l. *per annum*.

Queſtion 26. There is a *Leaſe* of certain Lands worth 32 l. *per annum*, more then the *rent* paid to the Lord for it, of which Land there is a *Leaſe* yet in being for ſeven yeares, and the *Leſſee* is deſirous to take a *Leaſe* in *reverſion* for 21 yeares, to begin when his old *Leaſe* is expired. the queſtion is, what ſumme of money is to be paid for this *Leaſe* in *reverſion*, accompting *compound Intereſt* at the *rate* of *6 per centum, per annum?*

Facit 250 l. 7 s 2 d.

Find by the *Table* in page 304, what 32 l. *rent* is worth in ready money for 21 years as if it were to begin preſently, which will be found 376.45024 l. Then by the *Table* in page 299, find what 376.45024 l. due at the end of 7 years to come is worth in ready money; ſo will it be 250 l. 7 s. 2 d. *proxime*, which is the *Anſwere* of the Queſtion.

CHAP. IV.

Chap. IV.

Containing a Geometricall Demonſtration of the Rule of Alligation alternate, and the uſe of the ſaid Rule in the compoſition of Medicines.

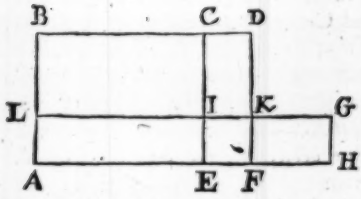
I. IF *three Numbers* A. B. C. *are given, in ſuch ſort that* A. *is leſſe then* B. *but greater then* C. *then if the difference betweene* A. *and* B. *be multiplied by* C. *and the difference between* A. *and* C. *be multiplied by* B. *the ſumme of thoſe Products will be equall to the Product ariſing from the Multiplication of* A. *by the ſumme of the ſaid differences: So if* A. *be* 7. B. 10, *and* C. 5. *the difference betweene* A. *and* B. *will be* 3. which being multiplyed by C. produceth 15; Alſo the *difference* between A. & C. is2, which being multiplied by B. produceth 20. Laſtly, the

		diff.	prod.
A. 7.	B. 10	2	20
	C. 5	3	15
		5	35

the *ſumme* of the ſaid *Products* is 35, which is equall to the *Product* of **A.** multiplied by the *ſumme* of the ſaid *differences*, viz. the *Product* of 7 by 5.

II. *The like propertie will be in any three Numbers qualified as aforeſaid, which is the thing required by the* Rule *of* Alligation, *alternate in the commixture of two things miſcible, and may be demonſtrated as followeth.*

Conſtruction.



Vide P. Herigone, Tom. 2.

Let **B** and **C** be forementioned (which you may ſuppoſe to be the *prices* of two things given to bee mixt) be repreſented by the right lines. } **A H & A E**

Let

Let A (the *mean price* aſſigned for the mixture) be——— A F.

Then will the *difference* between A F (the mean price) and A H. (the greater of the two prices miſcible) be——— F H.

Alſo the *difference* between A F (the meane price) and A E (the leſſer of the two prices miſcible) will be——— E F.

Then will the *ſumme* of the ſaid *differences* be—— E H.

Make A L equall to E F, and perpendicular to A H, and with the lines A H, A L, deſcribe the *Parrallelogram* A L G H, *viz.* ▭ A G.

Make A B equall to E H, and perpendicular to A H, and deſcribe the *Parallelogram* A B D F, *viz.* ▭ A D.

Alſo deſcribe the *Parallelogram* A B C E, *viz.* ▭ A C.

The

The Proposition to be Demonstrated.

▭ A G. + ▭ LC. = ▭ A D.

That is to say, the *Parallelogram* A L G H (or the *Product* arising from the *Multiplication* of the greater of the two prices miscible, by the *difference* between the *mean price* and the *lesser price*) together with the *Parallelogram* L B C I, (or the *Product* arising from the *Multiplication* of the *lesser* of the two *prices* miscible, by the *difference* between the *mean price* and the *greater price*) are equall to the *Parallelogram* A B D F (or the *Product* of the *mean price* multiplied into the *summe* of the said *differences*.)

= signifies *Equall to*.
: : signifies the middle of 4 proportionalls.
+ signifies *plus* or more, and is the signe of *Addition*.
— signifies *minus* or lesse, and is the signe of *Subtraction*.

Demonstration.

By *Construction* > EF or IK = LA or KF
Also by *Construction*. } FH or KG = LB or KD
Wherefore by 7 } KG . IK : : KD . KF
& 5 *Euclid. Elem.* }
And by 14 & 6 > ▭ FG = ▭ ID
Therefore (wch was to be demonstrated.) } ▭ AG + ▭ LC = ▭ AD

Coro-

Corollary.

Hence it is manifest, that if the *summe* of the *Products*, arising from the Multiplication of the *prices* (or *qualities*) of two things miscible, by the respective *Alternate differences* between the *mean price* and the said two *prices* miscible, be divided by the *summe* of the said *differences*, the *Quotient* will be the *mean price*, and such is the *Proofe* of the *Rule* of *Alligation alternate*.

When more then two prices are given to be mixed, the *Demonstration* will not be otherwise, for if the *summe* of every two *Products* arising from the Multiplication of two *alternate differences* into their respective *prices*, be equall to the *Product* of the *mean price* and the *summe* of the said *differences*, the *summe of all the said products* will also be equall to the *product* of the *mean price*, and the *summe* of all the *differences*.

Of the Composition of Medicines.

See Mr. *J. Dee* his Mathem. Preface also *P. Herigone* Tom 2. and Mr. *Mores*, Arithmetique.

I. *Medicines* and *Simples* in respect of their *qualities* are considered in some of these 5 wayes, *viz.* either as they are *hot* or *cold*, *moyst* or *drie*, or as they are *tem-*

perate; ſo that ſuch *Simples* or *Medicines* which work *heat* in our bodies are ſaid to be hot, ſuch cold which are the cauſe of coldneſſe, &c.

II. The *mean* or *middle* between the *extreme qualities* of *Heat* and *Coldneſſe*; alſo between *Drineſſe* and *Moyſture*, is called *Temperate* or the *Temperature*; from which each of the ſaid qualities *hot, cold, moyſt, dry*, doth differ in 4 *degrees*, ſo that a *Medicine* or *Simple* is ſaid to be either *temperate*, or elſe *hot, cold, moyſt*, or *dry*, in the firſt, ſecond, third or fourth *degree*.

III. If the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 be placed as you ſee from A to B, the *differences* between 5 (the middle number) and the Superiour numbers 6, 7, 8, 9. will be 1, 2, 3, 4. which may repreſent the 4 *degrees* of the *qualities hot* and *dry*, likewiſe the *differences* between 5 and the inferiour numbers

	Hot	*Dry*	
B	9	4	
	8	3	*Qualities hot and dry.*
	7	2	
	6	1	
	5	0	*Temperature.*
	4	1	
	3	2	*Qualities cold and moyſt.*
	2	3	
A	1	4	
	Cold	*Moyſt*	

numbers 4,3,2,1. will be 1,2,3,4. which may represent the 4 *degrees* of the *qualities cold* and *moist*, the *temperature* represented by 0, being the *mean* or *middle* from whence the said *degrees* doe proceed.

IV. Since the *Rule* of *Alligation alternate* requires, that of two things miscible, the one must *exceed* the *mean* propounded and the other be *lesse*; therefore the questions of *Alligation* in this kinde are to be wrought with the numbers in the aforesaid *Columne* A B, for by them, the *degrees* and *qualities* are discovered, being placed as you see in the *Columne* adjacent to A B, and for distinction sake, those numbers in the said *Columne* A B, may be called the *Indices* or *Exponents* of the *degrees*, which *Indices* are to be used in the same manner as the *prices* of Merchandizes in the questions of *Alligation alternate* in Chap. 17. of the preceding Book; and therefore those *examples* may be compared with these.

Prop. I.

Having divers Simples whose qualities are known, to make a composition or mix-

ture of them, in ſuch manner that the quality of the Medicine may be ſome mean amongſt the qualities of the Simples, and the quantity thereof any quantity aſſigned.

Exam. 1. An *Apothecary* hath foure ſorts of *Simples*, A, B, C, D, whoſe *qualities* are as followeth. *viz.* A is *hot* in the fourth *degree*, B is *hot* in the ſecond, C is *temperate*, and D is *cold* in the third *degree*; the queſtion is to know what quantities of each ought to be taken, to make a *Medicine*, whoſe quantity may bee 11 *Ounces*, and the quality in the firſt *Degree* of *heat*? Seek in the aforeſaid *column* A B, for the *Indices* or *exponents* of the qualities of the *Simples* given, *viz.* for A which is *hot* in the fourth *Degree*, take 9; for B which is *hot* in the ſecond, take 7; for C which is *temperate*, take 5; and for D which is *cold* in the third *degree*, take 3; that done, rank thoſe numbers in the ſame manner as the *prices* of Merchandizes in the queſtions of the 27. Chapter, *viz.* deſcend from the higheſt *degree* of *heat* unto the *temperature*, and ſo proceed downwards to the *degrees* of *cold*, ſetting the *Index* or *exponent* of the *mean quality* propounded, as common to them all: Then by crooked lines or otherwiſe, connect

next two such *Indices* whereof one may be greater then the *mean* & the other lesse, and proceeding according to the *Rules* of the 27 *Chapter*

Degr.		*Oun.*		*The proof.*
9		1	A	9...1 | 9
7	6 <	4	B	7...4 | 28
5		3	C	5...3 | 15
2		1	D	2...1 | 2
		9		9)54(6

you will find that to make a *Medicine* of 9 *Ounces*, and the *quality* resulting to be in the first *degree* of *heat*, you must take 1 *Ounce* of A (being that *Simple* which was *hot* in 4°.) 4 *Ounces* of B, 3 *Ounces* C, and 1 *Ounce* of D, as will be manifest by the proofe: Lastly, by the *Rule* of *Proportion* you may increase the *Medicine* to the quantitie of 12 *Ounces*, and yet the *qualitie* to continue in the first *degree* of *heat*, according to the following operation.

Oun.

9 — 1 — 12 (*Facit* 1 $\frac{1}{3}$ of A.

9 — 4 — 12 (*Facit* 5 $\frac{1}{3}$ of B.

9 — 3 — 12 (*Facit* 4 of C.

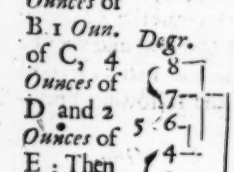
9 — 1 — 12 (*Facit* 1 $\frac{1}{3}$ of *D.*

The quantitie assigned 12 *Ounces.*

By other *connexions* of the *qualities*, other quantities of each *Simple* would ariſe but that hath been ſufficiently manifeſted in the queſtions of the 27 *Chapter*.

Exam. 2. Suppoſe there are five *Simples*, A, B, C, D, E, whoſe *qualities* are as followeth, *viz.* A is *hot* in 3°. B is *hot* in 2°. C is *hot* in 1°. D is *cold* in 1°. and E is *cold* in 3°. and it is required to mix 4 *Ounces* of B, with ſuch quantities of the reſt, that the *quality* of the *Medicine* may be *Temperate*?

Proceed as before, ſo will you find that to make a *medicine* of 11 *Ounces*, and the *qualitie* of the *Form* reſulting to be *Temperate*, you muſt take 1 *Ounce* of A, 3 *Ounces* of B 1 *Oun.* of C, 4 *Ounces* of D and 2 *Ounces* of E; Then ſince the quantitie of B in



the compoſition propounded is limited; *viz.* 4 *Ounces*, Finde numbers which may be in ſuch proportion to 4 (the quantitie of

of B assigned) as the numbers 1, 1, 4, 2 (the quantities of A, C, D, E, in the aforesaid *Composition* of 11 *Ounces*) are unto 3. (the quantitie of B in the said *Composition*) in manner following:

Ounces

3—1—4 (*Facit* 1 $\frac{1}{3}$ of A.)
3—1—4 (*Facit* 1 $\frac{1}{3}$ of C.) } to be mixed with foure *Ounces* of B.
3—4—4 (*Facit* 5 $\frac{1}{3}$ of D)
3—2—4 (*Facit* 2 $\frac{2}{3}$ of E.)

Prop. 2.

A *medicine* being compounded of divers *Simples* whose *qualities* and *quantities* are known, to finde the *degree* of the *Form resulting*, viz. the exact *Temperament* of the *medicine*.

Examp. 1. Suppose a *medicine* to be compounded of two *Simples*, viz. 6 *Ounces* of B *hot* in 4°. and 3 *Ounces* of C *hot* in 3°. and it is required to find the *temperament* of the *medicine*, viz. the *degree* and *quality* resulting from such mixture? Seeke in the aforelaid *Columne* A B for the *Indices* of the respective *degrees* and

qualities of the *Simples* given, and dispose them orderly in ranks right against their respective *quantities*, then multiply each *Index* into its respective *quantity* and divide the *summe* of the *products* by the *Summe* of the *quantities*, so will the *Quotient* bee the *Index* of the *degree* and *qualitie* of the *Medicine*: So in the said example, the Quotient will be found $8\frac{2}{3}$ which is the *Index* of $3\frac{2}{3}$ *degrees* of *heat*, and therefore the said *medicine* is *hot* in $3\frac{2}{3}$ degrees.

	Degr.	Quan.
	9	6
	8	3
	9)	78 ($8\frac{2}{3}$
		54
		24

Forasmuch as any two quantities miscible according to the *Rule* of *Alligation alternate*, are in such proportion one to the other, as the respective *alternate differences* between the *mean quality* of the mixture and the *qualities correspondent* unto the said quantities, the demonstration of the aforelaid *rule* will be manifest by the *Corollary* in page 323.

Examp. 2. Suppose a *medicine* to be compounded of 4 *Simples*, whose qualities and quantities are known, *viz.* 2 *Ounces*

of

of A *hot* in 3°. 3 *ounces* of B *hot* in 2°. 4 *ounces* of C *temperate*, and 5 *ounces* of D *cold* in 4°. and let it be required to finde the mean quality resulting from such mixture? Finde the quality resulting from the commixture of any two of the *Simples* given (according to the operation in the last example) then proceed in like manner with the *quality resulting*, and some other of the *Simples* given; So after due repetition of the same worke with every one of the *Simples*, the last operation will shew the *Index* of the *degree* and *qualitie* resulting from the commixture of them all; Or which is the same in effect and more brief,

Deg.oun.Prod.	
8..2	16
7..3	21
5) 37	(7 2/5
7 2/5..5	37
5...4	20
9)57	(6 1/3
6 1/3..9	57
1...5	5
14) 62	(4 1/7

De.oun.Prod.	
8...2	16
7...3	21
5..4	20
1...5	5
14) 62	(4 1/7

multiply each Index by its respective quantity, and divide the summe of the products

duſts by the ſumme of the quantities, ſo will the quotient be the Index of the degree and quality of the medicine; By either of which wayes you will finde $4\frac{1}{7}$ which is the *Index* of $\frac{4}{7}$ *degrees* of *heat* (for the difference between 5 the *Index* of the *temperature*, and $4\frac{1}{7}$ the *Index* found, is $\frac{4}{7}$ *degrees* of *heat*) which is the qualitie of the ſaid *medicine*.

Examp. 3. Suppoſe a *medicine* to be compounded of ſeverall *Simples*, whoſe *qualities* and *quantities* are as followeth, *viz.* 4 *Ounces* of a *Simple* which is *cold* in 2°. and *moiſt* in 1°. 5 *ounces hot* in 3°. and (in reſpect of *drineſſe* and *moiſture*) *temperate*; 3 *ounces hot* in 2°. and *dry* in 2°. 6 *ounces hot* in 1°. and *moiſt* in 4°. 4 *ounces cold* in 3°. and *moiſt* in 2°. the queſtion is to know the *Temper reſulting?*

In the reſolution of this queſtion there muſt be two diſtinct operations, each of them like to that in the laſt *Example*; *viz.*

1. Find in the ſame manner as before, the *degree* and *quality reſulting* from the commixture of the *qualities hot* and *cold*, ſo will you find $5\frac{7}{22}$ which is the *Index* of $\frac{7}{22}$ *degree* of *heat* (for the difference be-

between 5 and 5 $\frac{2}{22}$ the *Index* found, is $\frac{7}{22}$ *degrees of heat.*

Deg.oun.prod.		*Deg.oun.prod.*	
8..5	40	4...4	16
7...3	21	5...5	25
6...6	36	7...3	21
3...4	12	1...6	6
2..4	8	3...4	12

22)117(5$\frac{2}{22}$ 22)80(3$\frac{7}{11}$

2. Find in the same manner, the *Temper resulting* from the mixture of the *qualities dry* and *moist*; so will you find 3 $\frac{7}{11}$ which is the *Index* of 1 $\frac{4}{11}$ *degrees* of *moisture*; so the *qualitie* of the said *medicine* is $\frac{7}{22}$ *degrees* of *heat* and 1 $\frac{4}{11}$ *degrees* of *moisture*, as by the operation is manifest.

Prop. 3.

To augment or diminish a medicine in qualitie according to any degree assigned.

Suppose a *medicine* to be compounded as followeth, *viz.* 1 *dram* of a *Simple dry* in 4°. 2 *drams dry* in 3°. 2 *drams dry* in

in 2°. 1 *dram dry* in 1°. 1 *dram cold* in 1°. and 1 *dram cold* in 2°. So will the *quality* of the ſaid *medicine* be in 1 ½ *degrees* of *heat*, (as will be manifeſt by the ſecond *Propoſition*.) Now let it bee required to augment the ſaid *medicine* in *quality*, viz. to adde ſuch a quantity of ſome one of the *Ingredients*, (or of ſome other *ſimple*) which may raiſe the *quality* of the *medicine* ½ *degree*; ſo that the *Temperament* of the *medicine* after it is increaſed in quantity, may be in 2°. of *heat*. Make choice of ſuch a *ſimple*, the *Index* of whoſe *quality* may exceed (or at leaſt bee equall unto) the *Index* of the *quality* aſſigned, *viz.* make choice of that *ſimple* which is *hot* in 3°. whoſe *Index* is 8, then proceed according to the 1 *Example* of the firſt *Propoſition*; So will you finde that if 1 *dram* of the aforeſaid *medicine* be mixed with ½ *dram* of that *ſimple* which is *hot* in 3°. the *Temper reſulting* from ſuch mixture will bee in 2°. of *heat*.

Laſtly, by the *Rule* of *Three*, ſay, if 1 *dramme* require ½ *dramme*, what ſhall 8 *drammes* (the quantitie of the *medicine* firſt given) require?

Facit

Facit 4 *drammes*: So that if 4 *drams* of a *Simple* which is *hot* in 3°. bee mixed with 8 *drammes* of a *medicine* which is *hot* in 1 ½ *degree*, the *Temper refulting* will be in 2°. of *heat*, as by the Operation in the *Margent* is manifeſt.

Deg. Drams

7 { 6 ½ | 1
  { 8 | ½

If 1 — ½ — 8 (*Facit* 4 *drams*

The proofe,

Deg. Drams

6 ½ ... 8'52
8 ... 4 | 32
12) 84 (7

If it be required to *diminiſh* a *medicine* in *quality*, you are to make choice of ſuch a *Simple* the *Index* of whoſe *quality* may be leſſe then the *Index* of the *qualitie* aſſigned, and then to proceed as before.

Here obſerve, that if in queſtions of this nature, the quantities of the *Simples* be expreſt by *waights* of *divers denominations*, they are to be reduced to that *waight* which is of the *loweſt denomination* in the *queſtion*, according to the *Rules* of

of the 6. Chapter and by help of the ſubſequent *Table*.

Apothecaries waights.

℔. *A pound,*	*is equall unto*	12 *Ounces.*
℥ *An Ounce,*		8 *Drams.*
ʒ *A Dram,*		3 *Scruples.*
℈ *A Scruple,*		20 *Grains.*

The augmenting or diminiſhing of a *medicine* in reſpect of *quantity*; Alſo the finding of the *value* of any *quantitie* of a *medicine*, the *prices* of the *Ingredients* being known, will bee familiar to ſuch as underſtand the *Rule* of *Proportion*, and therefore I ſhall not inſiſt upon them.

CHAP.

CHAP. V.

Containing a Geometricall demonſtration of the Rule of False, by two Poſitions.

AFter due proceſſe is made according to the conditions in the queſtion, and the *Errors* of both *Poſitions* are diſcovered as is directed in the 5th. Rule of the 28th. Chapter, the number ſought may bee found according to the following Rules, viz.

When the Signes of the Errors are unlike.

Rule I. *As the ſumme of the errors is to the firſt error, ſo is the difference of the ſuppoſed numbers to a fourth proportionall, which being added to the firſt ſuppoſed number, when the ſaid firſt Suppoſition is leſſe then the ſecond, or ſubtracted from it when it exceeds the ſecond, the ſumme or remainder will bee the true Number ſought.*

When

When the Signes of the Errors are alike.

Rule II. *As the difference of the errors is to the first error, so is the difference of the supposed numbers to a fourth proportionall, which being added to the first supposed number, when the Signes are — or subtracted from it when the Signes are +, the summe or remainder will be the number sought.*

Example: Let it be required to divide 100l. amongst three persons *A*, *B*, *C*, in such sort that the share of *B*, may be the triple of the share of *A*, and foure pound over and above; Also that the share of *C*, may bee equall to the summe of the shares of *A*, and *B*; and 6 pound more. *Facit A*, 10 1/4 l. *B*, 36 1/4 l. *C*, 53 l. which three numbers added together, make 100 pound, and doe answer the conditions in the Question.

The first Rule *afore mentioned will be exercised in the two following varieties.*

Let the first *position* for the share of *A*, be

be 12, and the second *position* 8, then will the *errors* be found + 16 and — 22, and according to the first *Rule* the share of *A* will be found 10 $\frac{1}{4}$, and consequently the share of *B*, 36 $\frac{1}{4}$. and the share of *C*, 53.

Posit. *Errors.*

12 + 16

8 — 22

4 32...10..4 (1 $\frac{1}{4}$

12

10 $\frac{1}{4}$ for *A*.

Again, let the first *position* for the share of *A* be 9, and the second *position* 11, then will the *errors* be found — 14, and + 2, and according to the said first Rule, the share of *A* will be found as before 10 $\frac{1}{4}$.

Posit. *Errors.*

9 — 14

11 + 2

2 16... 14...2 (1 $\frac{1}{4}$

9

10 $\frac{1}{4}$ for *A*.

The second Rule will be exercised in the two following varieties.

Let the *Suppositious* Numbers for the share of *A* be 8 and 9, then will the *errors* be found —22, and — 14, and according to the said second *Rule*, the share of *A* will be found as before $10\frac{1}{4}$.

Posit. *Errors.*

8 — 22
9 — 14
1 8 .. 22 .. 1 ($2\frac{1}{4}$
8
$10\frac{1}{4}$ for *A*.

Again, let the *suppositions* for *A* be 14 and 11, then will the *errors* be found + 26 and + 2 and according to the said second Rule, the share of A will be found $10\frac{1}{4}$ as before.

Posit. *Errors.*

14 + 26
11 + 2
3 24 .. 26 .. 3 ($3\frac{1}{4}$
14
$10\frac{1}{4}$ for A.

The

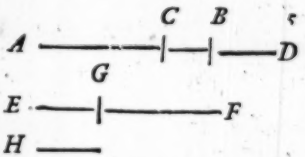
The *Rule* of *False* hath been much inlarged by *Gemma Phrisius*, *Simon Iacob*, *Ed. Leon* and others, who make the same capable of resolving questions which were formerly esteemed not resolvable without the Rule of *Algebra*, but in regard they have not given sufficient light (as I conceive) how to discover unto which of those *Rules* by them delivered, a question doth belong, there cannot arise any frugall use from their additionall Rules of *Squaring*, *Cubing*, &c. of the *positions*; wherefore the common *Rule* of *False* by *two positions*, as it is held forth in this Chapter, and in the 28 Chapter of the preceding Book agreeable to the sense of most Authors) is (as I suppose) the most usefull, which alwaies requires that there may be the same *reason* between the *errors* as is between the *differences* of the number fought, and the *suppositious* numbers, which will be onely in such questions where the number sought, and each supposed number is either increased, lessened, multiplied or divided by some common number, or contrarily when some common number is increased, lessened, &c. by the number sought and each supposed number; for in such Case, when the conditions of the question onely require

To discern what questions are resolvable by the ordinary Rule of False by two positions.

require *Addition* and *Subtraction*, there will be equall *reason* between the *errors*, and the *differences* of each suppoſed number and the number ſought: So if 3 be added to each of the numbers 5,7,12,(which may repreſent the number ſought, and the ſuppoſititious numbers) the ſummes will be 8, 10, 15, whoſe *differences* will bee equall to the *differences* of the former reſpectively; In like manner if 3 bee ſubtracted from each of the ſaid numbers, 5, 7, 12. the remainders will bee 2, 4, 9. whoſe *differences*, are the ſame with the former reſpectively: Moreover, when the conditions of the queſtion require *Multiplication* or *Diviſion*, the number ſought, and the ſuppoſed numbers being multiplyed or divided by ſome common number, will produce three numbers in the ſame proportion with the former, and therefore the *differences* of the latter will be in the ſame proportion with the *differences* of the former reſpectively, (by 19 & 5 *Euclid. Elem.*) whereby it is manifeſt, that the *errors* in the *Rule* of *False* by *two poſitions* (being the *differences* between the number reſulting from the number ſought, and the two numbers reſulting from the *ſuppoſititious* numbers by the ope-

operation of ſome common number) are in ſuch proportion as the *differences* between the number ſought and the two *ſuppoſed* numbers; which being granted, the firſt of the two *Rules* mentioned in *page* 337 may bee Demonſtrated in manner following.

Preparation.



1. Let the thing required be —— *A B*
2. Let the firſt *Hypotheſis* (given) be —— *A C*
3. Let the ſecond *Hypotheſis* (alſo given) be *A D*
4. Then it is manifeſt that the *differences* between the thing required, and the *ſuppoſitions* are —— *C B, B D*

5 Also it is manifest that the *difference* between the *suppositions* (which is given) is —— — — — — } *C D*

6 Let the *error* of the first *Hypothesis* (which is given) be —— —— } *E G*

7 Let the *error* of the second *Hypothesis* (likewise given) be —— — } *G F*

8 Then according to the property of the *rule* of *False* before defined, this proportion will arise. *viz.* } *EG. GF* : : *CB. BD*

9 And according to *Rule* I. in page 337 in regard the *Signes* of the *errors* are unlike, it will be —— — — — — } *EF. EG* : : *CD. H*

10 Which fourth proportionall *H* according to the said *Rule I.* (in regard the first *supposition* is lesse then the second) being added to the first *supposition* *A C* must give the thing sought, *viz.* } *AC + H = AB*

The

The Proposition to be Demonstrated;

$$AC + H = AB$$

Demonstration.

By the aforesaid preparation, *viz.* by the 8th. in order it is manifest that ——— } $CB.BD :: EG.GF$

Wherefore by the 18 *è* 5 *Euclid. Elem.* ——— } $CD.CB :: EF.EG$

And by the 9th. in order it is manifest that ——— } $CD.H :: EF.EG$

Wherefore by 11 *è* 5 *Euclid. Elem.* ——— } $CD.CB :: CD.H$

And by 9 *è* 5 *Euclid. Elem.* ——— } $H = CB$

Therefore (which was to be demonstrated.) ——— } $AC + H = AB$

Upon the same grounds, the *demonstration* of the latter part of the said *Rule* I. (*viz.* when the first *Supposition* exceeds the second) will bee obvious; and therefore I shall omit it.

When the Signes of the Errors are alike.

Preparation.

1	Let the thing required be	*A B*
2	Let the first *Hypothesis* (given) be	*A C*
3	Let the second *Hypothesis* (also given) be	*A D*
4	Then it is manifest that the *differences* between the thing sought and the Suppositions are	*B C*, *B D*
5	Also it is manifest that the *difference* between the *Suppositions* is	*C D*

6 Le

6 Let the *error* of the first *Supposition* (which is given) be——— *EF*

7 Let the *error* of the second *Supposition* (which is likewise given) be——— *EG*

8 Then according to the property of the *Rule* of *False* before defined, this proportion will arise, *viz.*——— *EF. EG :: BC. BD*

9 And according to *Rule* II. in page 338 in regard the *errors* are alike it will be——— *FG. EF :: CD. H*

10 Which fourth proportionall *H*, according to the said *Rule* II. (in regard the *Signes* are both +) being subtracted from AC (the first *Hypothesis*) must leave the thing sought, *viz.*——— $AC - H = AB$

The

The Propoſition to be Demonſtrated.

AC — H = AB

Demonſtration.

By the eighth in order, it is manifeſt that	BC. BD :: EF. EG
Therefore by 17 *è* 5 *Eucl. elem.*	CD. BC :: FG. EF
By the ninth in order, it is manifeſt that	CD. H :: FG. EF
Wherefore by 11 *è* 5 *Euclid. elem.*	CD. BC :: CD. H
Wherefore by 9 *è* 5 *Euclid. elem.*	H = BC
Therefore (which was to bee Demonſtrated.)	AC — H = AB

Chap. VI.

Containing 34 pleasant and subtile Questions, which will exercise all the parts of Natural Arithmetique.

Examples of the Rule of Three direct.

Question 1. IF a *wedge* of *Gold* waighing $17\frac{1}{7}$ lb. *Troy*, bee worth $679\frac{1}{7}$ lb. *sterling*, what is the value of $1\frac{3}{13}$ *grain* of that *Gold*?

Facit 2 d.

If $\frac{122}{7}$ lb. —— $\frac{4758}{7}$ l. —— $\frac{1}{4680}$ lb.

Facit 2 d.

Question 2. A *man* dying gave to his *eldest sonne* $\frac{2}{3}$ of $\frac{1}{4}$ of his *estate*, to his *second sonne* $\frac{1}{5}$ of $\frac{1}{2}$ of his *estate*, and when they counted their *portions*, the one had 40lb. more then the other, the remainder of the *estate* was given to the *wife* and *younger children*, the question is, what was the *portion* of the *eldest sonne*, also of the *second*, and how much did belong to the *wife* and *younger children*?

Facit the *eldest sons portion* 100lb.

the

the *ſecond ſons portion* 460 lb. and 440 lb. for the *wife* and *younger children*.

The Fractions being reduced, it will be manifeſt that the eldeſt ſonne had $\frac{1}{6}$, *and the ſecond* $\frac{1}{10}$, *alſo the difference of the ſaid Fractions is* $\frac{1}{15}$, *then ſay,*

I. If $\frac{1}{15}$ —— $\frac{40}{1}$ —— $\frac{1}{10}$

Facit 60 lb. *the ſecond ſonnes portion:*
adde 40 *the difference of their portions*

Facit 100 *the eldeſt ſonnes portion.*

II. If $\frac{1}{15}$ —— $\frac{40}{1}$ —— $\frac{1}{1}$

lb.

Facit 600 *the whole eſtate;*
ſubtract 160 *the ſum of both the ſons port.*
remains 440 *for the wife and younger children.*

Queſtion 3. A *young man* received $66\frac{2}{3}$ lb. which was $\frac{2}{3}$ of $\frac{1}{2}$ of his *elder brothers portion* and $3\frac{1}{2}$ times of his *elder brothers portion* was $1\frac{1}{4}$ times of his *fathers eſtate*, the *queſtion* is, what was the *fathers eſtate?*

Facit 560 lb.

I. If

I. If $\frac{1}{3}$ —— 66 $\frac{2}{3}$ —— 1
lb.

Facit 200 *the elder brothers portion*
$3\frac{1}{2}$

700 *equall to* $1\frac{1}{4}$ *of the whole eſtate.*

II. If $1\frac{1}{4}$ —— 700 —— 1
Facit 560 *the whole eſtate.*

Queſtion 4. There is a *ciſtern* ſupplied with water by three *pipes*, whoſe *cocks* are *A*, *B*, *C*; by *A* ſet open alone, the *ciſtern* will be filled in $2\frac{2}{9}$ *houres*, by *B* in $1\frac{1}{7}$ *houre*, by *C* in $\frac{1}{8}$ *houre*; the queſtion is, to know in what time the *ciſtern* will be filled when all the three *cocks* are ſet open at once?

$'$ $''$ $'''$
Facit $\frac{212}{619}$ *houre* or 22 : 17 : 38 $\frac{221}{619}$.

Find how much of the ciſtern will bee filled by each pipe in one and the ſame time, then it will bee, as the ſaid ciſterns or parts ſo found, to the correſpondent time; ſo is 1 *or the whole ciſtern to the time wherein it will be filled by all three pipes running together.*

I. If

houre ciſt. houre ciſt.

I. If $\frac{23}{9} - \frac{1}{1} - \frac{5}{8} - (\frac{45}{154}$ filled by *A.* in $\frac{5}{8}$ *houre*

II. If $\frac{12}{7} - \frac{1}{1} - \frac{5}{8} - (\frac{7}{16}$ filled by *B.* in $\frac{5}{8}$ *houre*

$1 -$ filled by *C.* in $\frac{5}{8}$ *houre*

$= 1\ \frac{251}{368}$ filled by *A.B.C.* in $\frac{5}{8}$ *houre*

ciſt. ho. ciſt.

III. If $1\ \frac{251}{368} - \frac{5}{8} - 1$

Facit $\frac{330}{619}$ *houre.*

Queſtion 5. A *ciſtern* in a certain *conduit* hath three *pipes* or *cocks*, viz. *A*, *B*, and *C*, of ſuch bigneſſe, that by *A*, the *ciſtern* will be filled in $\frac{1}{2}$ *houre*; by *B*, it will be emptied in $1\ \frac{3}{7}$ *houre*, and by *C* it will be emptied in $2\ \frac{1}{3}$ *houres*: Now ſince according to ſuch proportion there will be more water infuſed by *A*, then evacuated by *B*, and *C*, running together; if all the three *cocks* bee ſet open at once, the queſtion is to know in what time the *ciſtern* will be filled?

Facit $1\ \frac{9}{61}$ *houre.*

Finde how much of the ciſtern will be emptied in a certain time by B, *and* C, *running together, alſo how much of the ciſtern will be filled by* A *in the ſame time,*

ſo

so will the difference shew how much of the cistern is gained by the filling cock in the said time: Lastly as the cisterns or parts gained, is to the correspondent time; so is the whole cistern, to the time wherein it will be gained or filled.

houre cist. houre cist.

I. If $2\frac{1}{3}$ — 1 — $1\frac{1}{7}$ — ($\frac{12}{49}$ *emptied by* C

1- B

$1\frac{12}{49}$ B & C *in* $1\frac{1}{7}$ *houre.*

houre cist. houre

II. If $\frac{1}{2}$ — 1 — $1\frac{1}{7}$ — ($2\frac{6}{7}$ *filled by* A

$1\frac{84}{343}$ *gained by* A

cist. houre cist.

III. If $1\frac{84}{343}$ — $1\frac{1}{7}$ — 1

Facit $1\frac{9}{61}$ *houre, in which time the cistern will be filled.*

Question 6. Suppose a *Dog*, a *Wolf*, and a *Lion*, were to devoure a *Sheep*, and that the *Dog* could eat up the *Sheep* in an *houre*, the *Wolfe* in $\frac{1}{4}$ *houre*, and the *Lion* in $\frac{1}{2}$ *houre*; Now if the *Lion* begin to eat

eat $\frac{1}{8}$ *houre* before the other two, and afterwards all three eat together, the question is, in what time the *Sheep* would be devoured?

Facit $\frac{11}{104}$ *houre.*

houre Sheep houre.

I. If $\frac{1}{2}$ ——— 1 ——— $\frac{1}{8}$

Facit $\frac{3}{4}$ *eaten by the Lion before the Dog and Wolf began to eat.*

II. *Proceed according to the fourth question, so will you finde the remaining* $\frac{3}{4}$ *to be eaten by them all in* $\frac{3}{12}$ *houre, which added to* $\frac{1}{8}$ *gives* $\frac{11}{104}$ *houre, in which time the Sheep would be devoured.*

Question 7. If $120\frac{1}{3}$ lb. be to be distributed amongst three persons *A*, *B*, *C*, in such sort, that as often as *A* takes 5, *B* shall take 4; and as often as *B* takes 3, *C* shall take 2; what shall be the share of each?

Facit A $51\frac{4}{7}$ lb. *B* $41\frac{2}{35}$ lb. *C* $27\frac{11}{105}$ lb.

Finde three Numbers which may expresse the proportions of their shares, by the Rule of Three, or (to avoid Fractions) thus,

The

The Product of { 5 by 3 is 15 / 3 by 4 is 12 / 4 by 2 is 8 } { 5——4 / 3——2 / 15-12-8

The Proportions of their shares. { 15 / 12 / 8 } 35-120 1/3

l.
15-51 4/7 for *A*
12-41 9/35 for *B*
8-27 33/105 for *C*

Question 8. A *Governour* of a certain *Garrison*, being desirous to know how much money the *Port* or passage of the *Garrison* did amount unto in certain moneths, made choice of a loyall *servant*, giving him order to receive of every *coach man* passing with a *coach*, 4 d. of every *horseman* 2 d. and of every *footman* ½ d. Now at the years end, the *servant* making his accompt to the *Governour*, giveth him 94 l. 15 s. 10 d. and lets him know that as often as 5 passed with *coaches*, 9 passed on *horseback*; and as often as 6 passed on *horseback*, 10 passed on foot; the question is, how many *coaches*, *horsemen* and *footmen* passed? Answ. 2500 *coaches*, 4500 *horsemen*, 7500. *footmen*.

Find 3 proportionall numbers after the manner of the seventh question, which will be 5. 9. 15. then proceed as followeth,

	s. d.	
5 *Coaches* —	1-8	
9 *Horsemen*	1-6	
15 *Footmen*	0-7 ½	
	l. s. d.	
Lastly, say if	3-9½-94.15.10	5-(2500
		9-(4500
		15-(7500

Question 9. A Factor would exchange 780 lb. *sterling*, for *double ducats*, *dollars*, and *French crowns*, the *ducats* at 7 s. 6 d. the *piece*, the *dollars* at 4 s. 4 d. and the *French crownes* at 6 s. the *piece*; to be in such proportion, that $\frac{1}{4}$ of the number of *ducats*, may bee equall to $\frac{1}{8}$ of the number of *dollars*; and $\frac{2}{5}$ of the *dollars*, equall to $\frac{2}{15}$ of the *crownes*: the question is, how many *pieces* of each *coin* hee shall receive for his 780 pound. *Facit* 600 *ducats*, 900 *dollars*, 1200 *crownes*.

Finde three proportionall Numbers (after the manner of the seventh question) which will be 2, 3, 4.

$\frac{3}{4}$—

$\frac{1}{4}$ ——— $\frac{3}{8}$

$\frac{2}{5}$ ——— $\frac{8}{15}$

$\frac{3}{10}$. $\frac{3}{20}$. $\frac{1}{5}$

2. 3. 4

Then proceed as followeth,

	℔.		℔.
2 *ducats*—	$\frac{3}{4}$		
3 *dollars*—	$\frac{13}{20}$		
4 *crowns*—	$1\frac{1}{5}$		
	℔.	$\frac{3}{4}$—	(225
Say, if—	$2\frac{1}{5}$—780	$\frac{13}{20}$—	(195
		$1\frac{1}{5}$—	(360

℔.		℔.	
If $\frac{3}{8}$ —	1 *ducat*—	225—	(600 *ducats.*
If $\frac{13}{60}$—	1 *dollar*—	195—	(900 *dollars.*
If $\frac{3}{10}$—	1 *crown*—	360—	(1200 *crowns.*

Question 10. Twentie *Knights*, 30 *Merchants*, 24 *Lawyers*, and 24 *Citizens*, spent at a dinner 64 pound, which

was divided amongst them in such manner that 4 *Knights* paid as much as 5 *Merchants*, 10 *Merchants* as much as 16 *Lawyers*, and 8 *Lawyers*, as much as 12 *Citizens*; the question is to know the sum of money paid by all the *Knights*, also by the *Merchants*, *Lawyers* and *Citizens*?

Answer, the 20 *Knights* paid 20 pound, the 30 *Merchants* 24 pound, the 24 *Lawyers* 12 pound, and the 24 *Citizens* 8 pound.

Finde 4 Numbers to expresse the proportions of their payments, by the Rule of Three, *or (to avoid Fractions) in manner following, so will the proportionall numbers be* 4. 5. 8. 12. viz. 4 *Knights paid as much as* 5 *Merchants, or* 8 *Lawyers, or* 12 *Citizens.*

		4	5
The product of	4,10 8,is 320	10	16
	10 8,5,is 400	8	12
	8,5,16,is 640		
	5,16,12 is 960	320.400.640.960	
		4. 5. 8. 12	

Then presuppose a Summe for a Knight to pay, as 4 *s. and proceed as followeth*, viz.

20 *Knights*

	l	s.	d.		
20 *Knights*	4-	0-0			lb.
30 *Merchants*	4-	16-0			
24 *Lawyers*	2-	8-0		4--	(20
24 *Citizens*	1-	12-0		$4\frac{4}{5}$--	(24
Say if	12-	16-0	- 64	$2\frac{2}{5}$--	(12
				$1\frac{1}{5}$-	(8
					64

Question 11. A certain *man* with his *wife* did usually drinke out a *vessell* of *Beer* in 12 *dayes*, and the *husband* found by often experience, that his *wife* being absent, he dranke it out in twentie dayes; the question is, in how many dayes the wife alone would drinke it out?

Facit 30 *dayes.*

	dayes.
From	20
subtract	12
remains	8 *dayes of the husbands drinking, equall to* 12 *dayes of his wifes.*

Then say, If 8-12-20- (*Facit* 30 *dayes.*

Queſtion 12. If a *houſe* be to be built by three ſeverall *carpenters*, *A*, *B*, *C*. working in ſuch ſort, that *A* alone will finiſh it in 30 *dayes*, *B* in 40 dayes, and *A*, *B*, *C* together in 15 *dayes*, in what time would *C* build the *houſe*?

Facit 120 *daies.*

I. *Find in what time* A *and* B *working together will finiſh the houſe* (*after the manner of the* 4th *queſtion.*)

Facit 17 $\frac{1}{7}$ *dayes.*

II. *Suppoſing the work of* A *and* B *to be performed by one perſon as* D, *the houſe will be built by* D *in* 17 $\frac{1}{7}$ *dayes, but by* D *and* C *in* 15 *dayes*; *then finde* (*according to the* 11th. *queſtion*) *in what time* C *will finiſh the ſame.*

Facit 120 *dayes.*

The proof may be wrought according to the fourth queſtion.

Queſtion 13. Two *Travellers A* and *B*, perform a *Iourney* to one and the ſame place in this manner, *viz.* *A* travels 14 *miles* every day, and hath travelled eight *dayes* before *B* begins, upon the ninth day *B* ſets forward, and travells 22 *miles* every day, the queſtion is, in what time *B* ſhall overtake *A*?

Facit at the end of 14 *dayes.*

Find

Find how many miles B *gains of* A *in a day, which will be eight miles; alſo finde how many miles* A *had travelled before* B *did begin, which will be found* 112 *miles, then ſay*

miles day miles
If 8 —— 1 —— 112 —— (14 *dayes.*

Queſtion 14. Suppoſe a Greyhound to be courſing of a Hare, in ſuch ſort that the Hare takes five leaps for every foure leaps of the Greyhound, and is one hundred leaps diſtant from the Greyhound; Now if three of the Greyhounds leaps be equall to foure leaps of the Hares, the queſtion is, in how many leaps the Greyhound will obtain his prey?

Facit 1200 leaps.

I. If 3 —— 4 —— 4

Facit $5\frac{1}{3}$ *leaps of the Hare, equall to foure leaps of the Greyhound, and therefore the Greyhound in every foure of his leaps gains* $\frac{1}{3}$ *leap.*

II. If $\frac{1}{3}$ —— 4 —— 100 (*Facit* 1200 *leaps.*

Queſtion 15. There is a certain room whoſe Baſis is a long ſquare, which is in

circuit 50 ½ feete, and the height of the walls or ſides of the room is 8 ¼ feet; Moreover in one ſide of the room there is a rectangular window, whoſe height is five feet, and breadth foure feet; Now the ſaid room is to be furniſhed with hangings of Ell-broad ſtuffe at 3s. 4 d. the yard, the queſtion is to know how much money the ſtuffe will coſt?

Facit 5 l. 17 s. 6 $\frac{2}{9}$ d.

feet

Multiply { 50 ½ *the compaſſe about*
8 ¼ *the height.*

416 $\frac{3}{8}$ *the Area of ſquare feet in the ſides of the roome.*
Subtr. < 20 *the Area of the window.*

396 $\frac{3}{8}$ *Area to be furniſhed with hangings.*

feet
3 ¼
3

11 ¼ *Area of feet in one yard of ſtuffe.*

If 11 ¼ feet —— 3 ⅓ s. —— 396 $\frac{3}{8}$ feet
Facit 5 l. 17 s. 6 $\frac{2}{9}$ d.

Queſtion

Question 16. There is a certain walk which is a long square, whose length is 40 yards, and breadth 7 yards, to bee paved with rectangular stones, each stone being 28 Inches in length, and 24 Inches in breadth, the question is to know how many such stones will be requisite to pave the said walk.

Facit 540.

I. *Finde the Area of the walke in feet or Inches.* viz.

Inches

1440 *the length* } *of the walke.*
252 *the breadth* } -1-

362880 *the Area of square Inches in the walke.*

II. *Finde the Area of square Inches in one of the stones.*

Inches.

28 *the length* } *of a stone.*
24 *the breadth* }

672 *the Area of square Inches in a stone.*

III. If 672 —— 1 —— 362880

Facit 540 *stones.*

Question

Question 17. A *Merchant* would bestow 220l. in *Cloves*, *Mace* and *Nutmegs*, the *Cloves* being at 5 s. the pound, the *Mace* at 11 s. the pound, and the *Nutmegs* at 6 s. the pound; Now hee would have of each sort an equall quantitie, the question is how many pounds he may have of each sort?

Facit 200 lb.

s.
5
11
6

As 22-1-4400 s.-(200 lb. *weight*.

The proofe.

lb.	s.	L
200 at	5 *amounts unto* —	50
200 at	11 *amounts unto* —	110
200 at	6 *amounts unto* —	60
		220

Question 18. A *Factor* is to receive a summe of money, and is offered *Dollars* at 4 s. 4 d. which are worth but 4 s. 3 d.

or

or *French Crownes* at 6 s. 1 ½ d. which are worth but 6s. the queſtion is by which *Coyne* he ſhall ſuſtain the leaſt loſſe?

Anſwer, the *Dollars.*

If 4 s. 4 d.-1 d.- 6 s. 1 ½ d.-(1 $\frac{42}{104}$ d.

That is, in receiving the Dollars every 6 s. 1 ½ d. *looſeth* 1 $\frac{42}{104}$ d. *but in receiving the Crownes,* 6 s. 1 ½ *looſeth,* 1 ½ d. *which is a greater loſſe then* 1 $\frac{42}{104}$ d.

Examples of the Rule of Three Inverſe.

Queſtion 19. A *Butcher* agrees with a *Graſier*, for the feeding of 20 *Oxen*, during the ſpace of 12 moneths, accounting 30 dayes to a moneth, but at 2 moneths end, the *Butcher* addes 5 *Oxen* more, and 6 ⅔ moneths after that, he addeth 10 *Oxen* more, and then it is agreed between them, that the *Graſier* ſhall feed them all, ſo long time as will be equivalent to the keeping of the firſt twenty during 12 moneths; the queſtion is, how long time hee ſhall feed them all, after the putting in of the laſt 10?

Facit 1 *moneth.*

Conſider, that as he receives more Oxen to feed, he ought to keep them all the leſſe time; therefore work as the queſtion imports, in reciprocall proportion.

mon.

mon. *Oxen*
12 20
2 5 *mon.* *Oxen*

If 20—10—25—(8 25
$6\frac{2}{5}$ 10

If 25— $1\frac{2}{5}$ —35- (1 *mon.*

Question 20. If a *Garrison* consisting of 230 *Souldiers*, be victualled to endure a *Siege* of 96 dayes, how many *Souldiers* must be dismist, to the end the said provisions may at the same proportion of expence, bee sufficient for the *Souldiers* remaining to endure a *Siege* of 184 dayes?

Facit 110 to be dismissed, and 120 to remain in *Garrison*.

dayes *Sould.* *dayes.*
If 96 —230 — 184

Facit 120 *to remain in Garrison.*

Question 21. If when *Wheat* is at 24 s. the *quarter*, the penny white loaf ought to waigh 1 lb. 1 *Oun.* 12. *p. w. Troy*, what ought it to waigh when *Wheat* is at 3 lb. 12 s. the *quarter*?

Facit 4 *Ounces*, 10 *penny waight*, and 16 *grains*.

If

If $1\frac{1}{5}$ lb. — $13\frac{2}{5}$ *Oun.* — $3\frac{1}{5}$ lb.

1 —— 68 —— 15

Facit 4 *Oun.* 10 *p.w.* 16 *grains.*

Queſtion 22. If $4\frac{1}{4}$ *yards* in length, of *Cloth* which is 6 *quarters* broad, will make a *Garment*, how much *ſtuffe* which is $\frac{3}{4}$ *yard* in breadth, will make a like *garment*?

Facit $11\frac{3}{5}$ *yards.*

breadth length breadth.

If $\frac{4}{4}$ *y.* —— $\frac{19}{4}$ *y.* —— $\frac{3}{4}$ *y.*

Facit $11\frac{3}{5}$ *yards.*

Queſtion 23. If 13 *men* will reap 24 *Acres* in 2 *dayes*, in what time will 30 *men* reap 96 *Acres* at the ſame rate of working? Examples of the double Rule of Three.

Facit $3\frac{7}{15}$ *dayes.*

men Acres men.

I. 13 — 14 — 30 — (*Facit* $\frac{420}{13}$ *Acres.*

Acres dayes Acres.

II. $\frac{420}{13}$ — $\frac{2}{1}$ — $\frac{96}{1}$ — (*Facit* $3\frac{7}{15}$ *dayes.*

Queſtion 24. If 350 *Pyoners* caſt up a *Trench* of 200 *yards* in length in 24 *houres*,

houres, how many *yards* will 500 *Pyoners* caſt up in $8\frac{1}{2}$ *houres* ?

Facit $101\frac{4}{21}$ *yards.*

Pyoners, ho. Py.

I. 350 — 24 — 500 — ($\frac{24}{5}$ *houres.*

II. $\frac{24}{5}$ *ho.* — $\frac{200}{1}$ *y.* — $\frac{17}{2}$ *ho.* — ($101\frac{4}{2}$ *yards.*

Examples of the Rule of Fellowſhip.

Queſtion 25. Two *Merchants*, viz. *A*, and *B*, have entered *Company*; *A* puts in 500ſt. and at 4 *moneths* end takes out a certain ſumme leaving the remainder to continue 8 *moneths* longer; *B* puts in 250 lb. and at 5 *moneths* end puts in 300 lb. more, and ſo the whole ſumme continues 7 *moneths* longer. Now at the making of their *Accompt*, *A* findeth that hee hath gained $106\frac{2}{3}$ pound, and *B* gained $133\frac{1}{3}$ pound; the queſtion is to know how much *A* tooke out of the *banke* at 4 *moneths* end?

Facit 240 lb.

lb. mo.

B. 250-5-1250 } *the Products of the*
adde 300 } *money of* B *multiplied by the reſpective time.*
550-7-3850 }

5100

133 ⅓-5100-106 ⅔-(4080 | 500l.
4 *mo.*

ſubtract 2000 — 2000
500
8) 2080 (260

The money taken out by A-240

The proofe.

lb. mo.

A 500-4-2000 } *the Products of*
ſubtract 240 } *the money of* A *multipli. by the reſpective time.*
260-8-2080 }

4080

Note that this and ſuch like queſtions of the *Rule* of *Fellowſhip* with time have reſpect unto *Simple Intereſt*; for the *ſhares* of

of the *gain* or *losse* are in such proportion as the particular *Simple Interests* of the *stocks* for the respective times.

Question 26. Five *Merchants*, viz. *A*, *B*, *C*, *D* and *E*, have gained 2025 l. which they divide in such sort, that $\frac{1}{2}$ of the *share* of *A* is equall to $\frac{1}{4}$ of the *share* of *B*, or $\frac{1}{5}$ of *C*. or $\frac{1}{6}$ of *D*. or $\frac{1}{8}$ of *E*. the question is, what was the *share* of each *Merchant*?

Facit A 162 l. *B* 324 l. *C* 405 l. *D* 486 l. *E* 648 l.

Divide a number at pleasure which may be in such proportion as their shares, and proceed according to the subsequent Operation.

		lb.	
A 2			
B 4			
C 5			
D 6		2- (162	*for A whereof* $\frac{1}{2}$ *is* 81
E 8		4- (324	*for B whereof* $\frac{1}{4}$ *is* 81
As	25-2025	5- (405	*for C whereof* $\frac{1}{5}$ *is* 81
		6- (486	*for D whereof* $\frac{1}{6}$ *is* 81
		8- (648	*for E whereof* $\frac{1}{8}$ *is* 81
		2025	

Question 27. Two *Merchants A* and *B* are in *Company*, the sum of their *stocks* is

is 300 l. the *money* of *A* continuing in company 9 *moneths*, the *money* of *B* 11 *moneths*, they gain 200 l. which they divide equally; the question is to know how much each *Merchant* did put in?

Facit A 165 l. *B* 135 l.

Divide 300 *into two such parts which may be in proportion as* 11 *to* 9, *so will the greater part be the stocke of* A, *and the lesser the stocke of* B, *which stocks being multiplied by their respective times, the Products will be equall.*

11
9
As. 20 — 300 { 11 — 165 *for A*; 9 — 135 *for B*

Question 28. Two *Merchants*, viz. *A* and B are in *company*, *A* did put in 325 l. more then *B*, and the stock of *A* continued in *company* 7 $\frac{1}{2}$ *moneths*; *B* put in a certain summe which is unknown, and it continued in *company* 10 $\frac{1}{2}$ *moneths*; after a certain time they divide the gain equally; the question is what each *Merchant* did put in?

Facit B 750 l. and *A* 1075 l.

Divide the Product of the difference of their ſtocks and the time of A, *by the difference of their times, ſo will the quotient be the ſtock of* B. *which added to* 325 l. *gives the ſtock of* A.

325
7 1/2

3 1/4) 2437 1/2 (750 *ſtock of* B
325

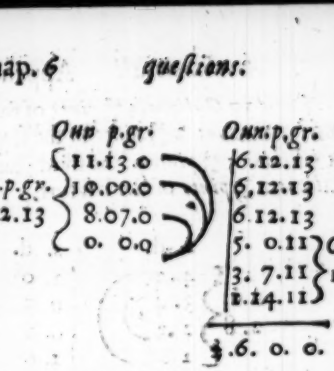
1075 *ſtock of* A

Examples of the Rule of Alligation alternate. How the fineneſſe of Silver is eſtimated. *Vid. pa.* 222.

Queſtion 29. A *Goldſmith* hath divers ſorts of *Silver*, viz. ſome of 11 *Ounc.* 13. *p. Fine*, other ſome of 10 *Ounces*, and another ſort of 8 *Ounc.* 7 *p. fine*: the queſtion is how much of each ſort he ought to take, and how much *Alloy*, to the end he may produce a *Maſſe* of *Silver* waighing 18 lb. 10 *Oun.* and bearing 6 *Oun.* 12 *p.* 13 gr. *fine*?

Facit, he muſt take of each of the ſorts of *Silver* 4 *pound*, 1 *Ounce*, 18 *p.* 11 4/15 grains, and of the *Alloy* 6 *pound*, 4 *Oun.* 4 *p.* 13 1/5 *grains*.

Oun.



If 2 lb. 6 *Oun.* — 18 lb. 10 *Oun.* — 6 *Oun.* 12 *p.* 13. *gr.*

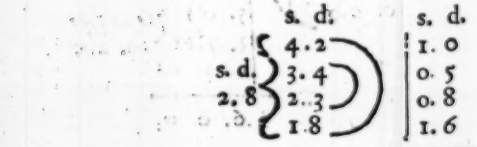
Facit 4 lb. 1 *Oun.* 18 *p.* 11 $\frac{1}{15}$ *gr.*

If 2 lb. 6 *Oun.* — 18 lb 10 *Oun.* — 10 *Oun.* 2 *p.* 9 *gr.*

Facit 6 lb. 4 *Ounces* 4 *peny w.* 13 $\frac{1}{3}$ *gr.*

Queſtion 30. A *Vintner* having divers ſorts of *wines*, viz. ſome that ſtands him in 4 s. 2 d. the *Gallon*, other ſome of 3 s. 4 d. the *Gallon*, ſome again of 2 s. 3 d. the *Gallon*, and other ſome of 1 s. 8 d. the *Gallon*; is deſirous to fill a *Hogſhead* containing 63 *Gallons* with a mixture of theſe *wines* which he may afterwards afford for 2 s. 8 d. the *Gallon*: How much of each ſort ought he to take?

Facit 17 *Gallons*, $4\frac{28}{43}$ *pints* of the first sort; 7 *Gallons* $2\frac{26}{43}$ *pints* of the second; 11 *Gallons* $5\frac{11}{43}$ *pints* of the third; and 26 *Gallons* $2\frac{22}{43}$ *pints* of the last sort.



s. d. *gal.* s. *gal.* *pint.*
If 3. 7 — 63 — 1 — (*Facit* 17 : $4\frac{28}{43}$
s. d. *gal.* d.
If 3. 7 — 63 — 5 — (*Facit* 7 : $2\frac{26}{43}$
s. d. *gal.* d.
If 3. 7 — 63 — 8 — (*Facit* 11 : $5\frac{11}{43}$
s. d. *gal.* s. d.
If 3. 7 — 63. — 1. 6 - (*Facit* 26 : $2\frac{22}{43}$

See *Chap.* 4. of this Appendix.

Question 31. An *Apothecary* hath severall *Simples*, viz. *A hot* in 3°. *B hot* in 2°. *C temperate*, *D cold* in 2°. and *E cold* in 4°. Now he desires to make a *Medicine* of those *Simples*, in such sort that the *temper* thereof in respect of *qualitie* may be in 1°. of *heat*, and the *quantitie* $8\frac{1}{2}$ *Drams*

Drams, the demand is what quantitie of each *Simple* he muſt take?

Facit 4½ *Drams* of *A.* ½ *Dram* of *B.* 1½ *Dram* of *C.* 1 *Dram* of *D.* and 1 *Dram* of *E.*

Degr.		*Drams.*	
8	1,3,5	9	*A.*
7	1	1	*B.*
6 5	2, 1	3	*C.*
3	2	2	*D.*
1	2	2	*E.*
		17	

	Drams	
If 17 —— 9 —— 8½ —— (*Facit* 4½		*A.*
If 17 —— 1 —— 8½ —— (*Facit* ½		*B.*
If 17 —— 3 —— 8½ —— (*Facit* 1½		*C.*
If 17 —— 2 —— 8½ —— (*Facit* 1		*D.*
If 17 —— 2 —— 8½ —— (*Facit* 1		*E.*
	8½	

Queſtion 32. A *Merchant* buyeth 2 ſorts of *Clothes*, viz. of *blacke* and of *white* for 68lb. 2 s, after the rate of 21 s. Examples of the Rule of Falſe poſition.

the *yard* for the *blacke*, and 12 *s.* the *yard* for the *white*, and he taketh ſo much of each ſort, that $\frac{2}{3}$ of the number of *yards* of the *blacke*, are equall to $\frac{3}{5}$ of the *white*; the demand is, how many *yards* he bought of each ſort?

Facit 42 *yards* of *blacke*, and 40 *yards* of *white*.

Queſtion 33. A certain *Uſurer* putteth forth 186 *l.* at *Simple Intereſt*, which in a certain time gaineth 36 *Dollars*: Alſo at the ſame rate of *Intereſt per centum*, he putteth forth 360 *l.* which gaineth in a certain time 90 *Dollars*; Now the ſumme of the *moneths* wherein both the ſaid numbers of *Dollars* were gained is 20 *moneths*, The *queſtion* is to know in what time the 36 *Dollars*, alſo the 90 *Dollars* were gained?

Facit the 36 *Dollars* were gained in $8\frac{4}{11}$ *moneths*, and the 90 *Dollars* in $11\frac{1}{11}$ *moneths*.

The proofe may be wrought by the double Rule of Three.

Queſt. 34. A *Merchant* putteth forth 2500 *l.* for 4 *yeares* at 8 *per Cent. per Ann.* in ſuch manner, that at the end of each of the ſaid 4 yeares, he is to receive

an

an equall ſumme, and that at the 4 yeares end, as well the *Capitall* as the *Intereſt* may be ſatisfied; the queſtion is, what ſumme of money ought to be paid at every yeares end?

Facit 754 $\frac{14117}{17602}$ l. *as will be manifeſt by the ſubſequent proofe.*

I. 100 — 108 — 2500 — (2700
ſubtract the firſt payment — 754 $\frac{14117}{17602}$

1945 $\frac{3485}{17602}$

II. 100 — 108-1945 $\frac{3485}{17602}$ —(2100 $\frac{14125}{17602}$
ſubtract the 2d. payment —754 $\frac{14117}{17602}$

1346 $\frac{328}{17602}$

III. 100 —108-1346 $\frac{328}{17602}$ —(1453 $\frac{12134}{17602}$
ſubtract the 3d. payment. — 754 $\frac{14117}{17602}$

698 $\frac{15529}{17602}$

IV. 100 —108- 698 $\frac{15529}{17602}$ —(754 $\frac{14117}{17602}$
the laſt payment, — 754 $\frac{14117}{17602}$

0

the *yard* for the *blacke*, and 12 *s.* the *yard* for the *white*, and he taketh ſo much of each ſort, that $\frac{1}{6}$ of the number of *yards* of the *blacke*, are equall to $\frac{1}{8}$ of the *white*; the demand is, how many *yards* he bought of each ſort?

Facit 42 *yards* of *blacke*, and 40 *yards* of *white*.

Queſtion 33. A certain *Uſurer* putteth forth 186 l. at *Simple Intereſt*, which in a certain time gaineth 36 *Dollars*: Alſo at the ſame rate of *Intereſt per centum*, he putteth forth 360 l. which gaineth in a certain time 90 *Dollars*; Now the ſumme of the *moneths* wherein both the ſaid numbers of *Dollars* were gained is 20 *moneths*, The *queſtion* is to know in what time the 36 *Dollars*, alſo the 90 *Dollars* were gained?

Facit the 36 *Dollars* were gained in 8 $\frac{8}{11}$ *moneths*, and the 90 *Dollars* in 11 $\frac{1}{11}$ *moneths*.

The proofe may be wrought by the double Rule of Three.

Queſt. 34. A *Merchant* putteth forth 2500 l. for 4 *yeares* at 8 *per Cent. per Ann.* in ſuch manner, that at the end of each of the ſaid 4 yeares, he is to receive

an

an equall ſumme, and that at the 4 yeares end, as well the *Capitall* as the *Intereſt* may be ſatisfied; the queſtion is, what ſumme of money ought to be paid at every yeares end?

Facit 754 $\frac{14117}{17602}$ l. *as will be manifeſt by the ſubſequent proofe.*

I. 100 — 108 — 2500 — (2700
ſubtract the firſt payment — 754 $\frac{14117}{17602}$

1945 $\frac{3483}{17602}$

II. 100 — 108-1945 $\frac{3483}{17602}$ — (2100 $\frac{14325}{17602}$
ſubtract the 2d. payment — 754 $\frac{14117}{17602}$

1346 $\frac{208}{17602}$

III. 100 — 108-1346 $\frac{208}{17602}$ — (1453 $\frac{12174}{17602}$
ſubtract the 3d. payment. — 754 $\frac{14117}{17602}$

698 $\frac{15679}{17602}$

IV. 100 — 108- 698 $\frac{15679}{17602}$ — (754 $\frac{14117}{17602}$
the laſt payment, — 754 $\frac{14117}{17602}$

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CHAP VII.

Containing sundry pleasant and choice Questions, which may serve as a Recreation, to new beginners in Algebra *by Species.*

An Explanation of the Signes or Notes, used in the Questions of this Chapter.

1. THis *Character* + represents the words *more by*, and is the signe of *Addition* or *Affirmation*; So 8 + 4 signifie 8 *more by* 4, or 4 added to 8, or the *Summe* of 8 and 4, that is, 12.

2. This *Character* — denotes the words *lesse by*, and is the signe of *Subtraction* or *Negation*; So 12 — 3 signifie 12 *lesse by* 3, or 3 subtracted from 12, or the difference between 12 and 3, that is, 9.

3. This *Character* = represents the words equall to, and is the note of an *Æquation*; So 7 + 3 = 6 + 4 are to be read *thus*, 7 *more by* 3, is equall to 6 *more by* 4; In like manner in *Species* or *Letters*, viz. If *A* be 5, *B* 4. *C* 12, and *D* 3. then

A

$A + B = C - D$ are to be read thus; *A more by B* is equall to *C, lesse by D*, that is, $5 + 4 = 12 - 3$ or 5. *more by* 4 is equall to 12 *lesse by* 3; that is, 9 is equall to 9.

4. Two or more *Letters* conjoyn'd without any note between them, signifie the *Product* of the numbers represented by those *Letters*; So if *A* be 6, and *B* 4. then *A B* signifies the *Product* of 6 multiplied by 4, that is, 24: Also if *B* be 5, *C* 7, and *D* 8. then *B C D* signifies the *Product* arising from the *continuall Multiplication* of the numbers 5, 7, and 8; that is 280.

5. *Letters* placed in form of a *Fraction*, viz. above and beneath a line signifie a *Quotient* arising from the *division* of the numbers represented by the *letters* above the line, or the *Dividend*, by the numbers represented by the *letters* underneath the line, or the *Divisor*: So if *B* be 12 and *C* 4. then $\frac{B}{C}$ that is, (in the *Analyticall* phrase) *B applied* to *C*, signifies $\frac{12}{4}$ which is equall to the *quotient* of 12 divided by 4; that is, 3. In like manner if *A* be 5, *B*, 6. *C*, 3, and *D*, 2, then by $\frac{A B}{C + D}$ is

underſtood, the *quotient* ariſing from the *diviſion* of the *Product* of 5 and 6; (that is 30) by the *ſumme* of 3 and 2 (that is 5) which *quotient* will be 6; for 30 being divided by 5 quoteth 6.

6. *Foure points* placed *thus* : : denote the middle of 4 *Proportionalls*: So if *A* bee 3, *B* 12, *C* 4, then *A*. *B* : : *C*. $\frac{BC.}{A}$ are to be read *thus*: As *A* is to *B*, ſo is *C* to $\frac{BC.}{A}$ or if *A* give *B*, then *C* will give $\frac{BC.}{A}$ that is, as 3 is to 12, ſo is 4 to $\frac{48}{3}$ (or 16.)

7. This *letter q* placed next after a *Capitall letter* denotes the *Quadrate* or *Square* of the number repreſented by ſuch *Capitall letter*; So if *A* be 7, then by *A q* is ſignified the *ſquare* of 7, that is 49: Alſo *q q* is the ſigne of a *biquadrate*; So if *C* be 2, then *Cqq* ſignifies the *biquadrate* of 2, that is 16: In like manner the ſmall letter *c* placed nextafter a *capitall letter*, is the ſign of the *Cube* of the number repreſented by ſuch *capitall*; ſo if *A* be 2, then by *A c* is ſignified 8; that is, the *Cube* of 2.

8. This

8. This *Character* ſ denotes the *ſquare root* of the *ſquare number* repreſented by the *Species* placed next after ſuch *character*: So if *Aq* or the *ſquare* of *A* be 16, then *A* or ſ *Aq* is 4. In like manner ſc. denotes the *Cube root*; ſqq the *biquadrate root*: But if a *Poteſtas* (whether it be a *ſquare Cube*, &c.) compounded of many letters, be included between two *colons*, *viz.* there being two points placed both before and after the ſaid *letters*, then the aforeſaid ſignes denote the root univerſall relating to all the *letters* ſo included: So if *Cq* be 25 and *N* 9. then by ſ: *Cq* — *N*: is underſtood 4. being the *ſquare root* of the remainder after *N* is ſubtracted from *Cq*, *viz.* 25 *leſſe by* 9 is 16, whoſe *ſquare root* is 4.

Of the method uſed in the Queſtions of this Chapter.

That wch I principally aim at in this *Chap.* is, to give the ingenious *Reader*, whom I preſuppoſe to be in ſome meaſure acquainted with the *Elements* or parts of *Speciosa* or *Symbolicall Arithmetique*, a taſt of the *Praxis* of *Algebra* in *Species*, in ſuch *queſtions* which may exerciſe ſome of the principall *Rules* hitherto invented, for the reſo-

resolution of *Æquations* in numbers: And since in the processe of the work there may be different methods, I conceive it will bee necessary to give some generall *Rules* and directions for the better understanding of the subsequent questions, and therefore you may observe as followeth, *viz.*

A *Question* being propounded, it will be convenient (for the avoyding of confusion) to represent *known quantities* by *Consonants*, and *unknown* by *Vowels*: And when after due ratiocination and processe made, either by *adding*, *subtracting*, *multiplying* or *dividing*, according to the conditions in the question, an *Æquation* is found, it is to be reduced (if need require) either by *Depression*, *Transposition*, *Application* or other *Rules* of *Analyticall Reduction*, in such sort that those quantities which are known and not compounded with unknown, may solely possesse one part (or side) of the *æquation*, and those which are unknown, the other, which unknown part of the *æquation* may bee considered in a threefold respect, *viz.*

The

The unknown part of the æquation is either
1. *Pure.*
2. *A Poteſtas.*
3. *Adfected.*

The unknown part of the *æquation* is ſaid to be *Pure*, when the ſide or number unknown is found to be equall to a known quantitie whether the ſaid known quantity be expreſt by one *Conſonant* or a *Summe*, *Difference*, *Rectangle* or *Quotient* expreſt by two or more *conſonants*, as in the 5th. *Æquation* of the 6th. *Queſtion*, where $A = 5$. Alſo in the 7th. *Æquation* of the firſt *queſtion*, where $A = \frac{C + B.}{2}$ In like manner in the 11th. *Æquation* of the 4th. *Queſtion*, where $A = \frac{B q D}{C 2 D - B D}$ and the like may be found in the 10th. of the 3d. the 11th. of the 5th. *queſtions*, &c. which kind of *Æquations* are reſolved either by *Addition*, *Subtraction*, *Multiplication* or *Diviſion*, as the known part of the *Æquation* will ſhew.

2. The unknown part of the *Æquation*

tion is said to be a *Potestas*, when the *Quadrate*, *Cube* or other *Power* of the quantity unknown, is found to be equall to a known quantity; as in the 8th. *Æquation* of the 13th. *Question*, where $A\,c. = \frac{B}{2}$ Also in the 9th. *Æquation* of the 14th. *Question*, where $A\,q = \frac{R\,B}{S}$ which kind of *Æquations* are resolved by extracting the Root of the known quantity, according to the signe annexed to the *Potestas* of the quantity unknown, as in the afore mentioned *Æquation* where $A\,c. = \frac{B}{2}$. the *Cube root* of $\frac{1}{2}$ of the known number represented by B is the value of the *Number* or *Thing* represented by A: Also where $A\,q = \frac{R\,B}{S}$ the *square root* of the *Quotient* found by dividing the *Product* of the known numbers R and B, by the known number S, is the value of the *Number* or *Thing* represented by A.

3. Of *Adfected Æquations* there are divers kinds, but in this place I shall onely have occasion to mention such as will be

be found in ſome of the *ſubſequent queſtions, viz.* when the unknown part of the *Æquation* conſiſts of two *Termes*, one of which is ſome *Poteſtas* of the quantitie unknown, and the other is a *Rectangle* under the *ſide* (or ſome *Poteſtas* of the quantity unknown) and ſome known quantity, (whether the ſaid known quantity bee repreſented by one *Conſonant*, or a *Summe, Difference, Rectangle* or *Quotient* repreſented by 2 or more *Conſonants*) which known quantity is by ſome *Authors* called the *Coefficient*, and ſuch *Æquations* will fall under ſome of the three following *varieties, viz.*

1. $CA-Aq=N$ | $CAq-Aqq=N$
2. $Aq+CA=N$ | $Aqq+CAq=N$
3. $Aq-CA=N$ | $Aqq-CAq=N$

} and ſuch like.

In each of which *equations* you may obſerve 3 *Termes*, the *Indices* or *Expoſents* of whoſe *Degrees* do equally aſcend in an *Arithmeticall Proportion, viz.* the *Index* or *Exponent* of the known quantity ſolely poſſeſſing one ſide of the *æquation* repreſented by *N*, being the *loweſt degree* of the *æquation*; the *Exponent* of the

the side or *Potestas* of the quantity unknown which is drawn into the *Coefficient*, being the *middle degree* of the *aquation*; and the *Exponent* of the *Potestas* of the quantity unknown which hath no *Coefficient*, being the *highest degree* of the *aquation*: So that assuming 0 to bee the *Index* or *Exponent* of *N*, the *Exponents* of the *degrees* in each of the aforesaid 3 *aquations* on the left hand, will be 0. 1. 2. and the *Exponents* of the other three *aquations* will be 0. 1. 4.

Now the *adfected aquations* before mentioned, and such like, are resolved by certain generall *Rules* or *Theoremes* demonstrated by divers *Authours*, which *Rules* to the end the *subsequent questions* may be the more usefull: I shall expresse as well in *Symbols* as in *words*; and as touching other *adfected aquations*, the *Exponents* of whose *degrees* keep not an *Arithmeticall proportion*, the curious *Reader* may find what is hitherto known, in the works of the learned and famous modern *Analysts*, *viz.* the works of *Vieta*, *Mr. Oughtreds Clavis Mathemat. Limat. Mr. Harriots Ars Analytica*, *Renatus des Cartes* his *Geometry* in *French*; Also the same translated into *Latine* by

Fran.

Fran. Schooten, with his *Commentary* thereupon, and the *Appendix* concerning *Cubicall æquations*, annexed unto the ſaid *Fran. Schootens Treatiſe* of the deſcription of *Conicall ſections in Plano.*

In the firſt of the afore mentioned *æquations, viz.* $C A - A q = N$ where the *higheſt degree is negative*, the value of A or the quantity unknown will be dubious, *viz.* there will be two *ſides* or *numbers* found, either of which may bee the value of A, which *ſides* or *numbers* will be found by the following *Rule, viz.*

In the Æquation $C A - A q = N$.

Rule I.
$$\begin{cases} \frac{C}{2} + \sqrt{u : \frac{Cq}{4} - N} := A \text{ the greater.} \\ \frac{C}{2} - \sqrt{u : \frac{Cq}{4} - N} := A \text{ the leſſer.} \end{cases}$$

That is to ſay in words, If half the Coefficient (repreſented by C*,) be increaſed with the* Square root *of the remainder found by ſubtracting the known quantity (repreſented by* N*) from* $\frac{1}{4}$ *of the Square of the Coefficient, the ſumme will be the greater number or ſide ſought: Or if half the Co-*

efficient be lessened by the Square root *of the remainder found &c. the remainder will be the lesser.*

By which *Rule* the 6th. *equation* of the 15th. question; also the 8th. of the 16th. the 10th. of the 17th. the 11th. of the 18th. and the 12th. of the 19th. are resolved.

In the 2d. of the afore mentioned *equations* where $Aq + CA = N$, the value of A, or the quantity unknown will be found by the following *Rule*, viz.

In the equation, $Aq + CA = N$.

Rule II. $\left\{ \int u : \frac{Cq}{4} + N : - \frac{C}{2} = A. \right.$

That is to say in words, If the Square root *of the summe of* $\frac{1}{4}$ *of the Square of the Coefficient (represented by* C*) and the known quantitie (represented by* N*) be lessened by half the Coefficient, the remainder will be the number or side sought.*

By which *Rule*, the 6th. *equation* of the 20th. Question; also the 21th. of the 21th. and the 10th. of the 22th. are resolved.

In the 3d. of the afore mentioned *equations*, where $Aq - CA = N$, the value of A or the *quantity sought* will be found by the following *Rule, viz.*

In

In the 2 Æquation, $Aq - CA = N$,

Rule III. $\frac{C}{2} + \sqrt{\frac{Cq}{4} + N} = A$

That is to say in words, If half the Coefficient (represented by C) be increased with the square root of the summe of ¼ of the square of the Coefficient, and the known quantity (represented by N) the Aggregate will be the number or side sought.

By which *rule* the 13th. *equation* of the 23th. Question; also the 16th. of the 24th. are resolved.

Note that in any of the afore mentioned *equations* when the *Coefficient* is drawn into some *Potestas* of the quantity sought, that is, when the *middle degree* of the *equation* is a *Square, Cube, &c.* as $CAq - Aqq = N$, or $CAc - Acc = N$ and such like, then the afore mentioned *rules* do find the value of such *Potestas* of the quantity sought; and therefore the *root* thereof is to be extracted according to its kind, as in the 12th. *equation* of the 19th. Question; also the 10th. of the 24th.

Moreover, when no *Species* is drawn into the quantity unknown, which is of the middle degree of the *equation*, then 1 or

unity is the *Coefficient* of such quantity: as in this *aequation*, $Aq + A = N$. and such like.

The *Demonstration* of the three *rules* before mentioned, will be manifest by *Sect.* 9. *Cap.* 16. of the aforesaid *Clavis Mathemat.* Also by the third and fourth *Diagrams* in *Renat. Des Cartes* his *Geometrie.*

The questions follow:

Question 1. *There are two numbers whose summe is* 26, *and their difference is* 8, *what are the numbers?*

1	Let the *summe* of the two numbers be ——	B
2	Let the *difference* be	C
3	Let the *greater number* be ——	A
4	It is evident that if the *greater number* be subtracted from the *summe*, the remainder will be the *lesser*; therefore the first *aequation* lesse by the third, will be equall to the *lesser number*, which is ——	$B - A$

5. It

5 It is alſo manifeſt, that if the *leſſer number* be ſubtracted from the *greater*, the remainder will bee the *difference* between them; therefore the 3d. *æquation* leſſe by the 4th. will be equall to the 2d. *æquation*, viz. $A - B + A = C$

6 The 5th. *æquation* by *tranſpoſition* of $-B$ will be —— $2A = C + B$

7 If both parts of the 6th. be *applied* to 2. it will be —— $A = \frac{C + B}{2}$

Which laſt *æquation*, in words, is the following *Theoreme*, *viz.*

Half the ſumme of the ſumme and difference of any two numbers is equall to the greater number.

Illuſtration.

The *ſumme* of the two numbers in the queſtion is —— 26
The *difference* given is —— 8
Therefore the *ſumme* of the *ſumme* and *difference* is —— 34

But according to the afore mentioned *Theoreme*, half the *summe* of the *summe* and *difference* is equall to the *greater*; therefore the *greater number* is ——— } 17

Also if the *greater number* bee subtracted from the *summe*, the remainder will bee the *lesser*, therefore the *lesser number* is ——— } 9

So the two numbers sought are found to be 17 and 9, whose *summe* is 26. and *difference* 8, as was propounded. ——

Otherwise.

1	Let the *summe* be	*B*
2	Let the *difference* be ———	*C*
3	Let the *lesser number* be ———	*A*
4	Then for as much as the *lesser number* together with the *difference* are equall to the *greater*, therefore the *summe* of the second and third *æquations* is equall to the greater number which is ——	*C* + *A*

5. And

5 | And ſince the *greater number* together with the *leſſe* are equall to the *ſumme*; therefore the *ſumme* of the third and fourth *æquations* is equall to the firſt, *viz.* } $C + 2A = B$

6 | The fifth *æquation* by *tranſpoſition* of C, is — } $2A = B - C$

7 | If both parts of the 6th. *æquation* be *applied* to 2, it will be — } $A = \frac{B-C}{2}$

Which 7th. *æquation*, in words, is the following *Theoreme*, *viz.*

Half the difference between the ſumme and difference of any two numbers, is equal to the leſſer number.

Illuſtration.

The *ſumme* of the two numbers given is — 26

The *difference* given is — 8

Therefore the *difference* between the *ſumme* and *difference* is — 18

But according to the afore mentioned *Theoreme*, *half the difference* &c. therefore the *leſſer number* is — 9

Also the *lesser number* together with the *difference* are equall to the *greater*; therefore the *greater number* is —— 17

So the 2 Numbers sought are found to be 9 and 17, whose *summe* is 26, and *difference* 8, as was propounded.

Question 2. *A certain man being demanded what was the age of each of his* 4 *sonnes; answered, that his eldest sonne was* 4 *yeares elder then the second; his second sonne was* 4 *yeares elder then the third; his third sonne was* 4 *yeares elder then the fourth or youngest; and his fourth or youngest sonne was halfe the age of the eldest: the question is, what was each sonnes age?*

1 Let the foure *yeares* mentioned in the question be —— *B*

2 Let the age of the *youngest sonne* be —— *A*

3 Then since the third *sonne* was foure *yeares* elder then the youngest, the summe of the first and second *æquations* will bee the age of the third *sonne*, *viz.* *A* + *B*

4. Again

4 Again, ſince the ſecond *ſonne* was foure *yeares* elder then the third; therefore the ſum of the firſt and third *æquations* will bee the age of the ſecond *ſonne*, *viz.* — $A + 2B$

5 Alſo ſince the *eldeſt ſonne* was foure *yeares* elder then the ſecond; therefore the ſumme of the firſt and fourth *æquations* will be the age of the *eldeſt ſonne*, *viz.* — $A + 3B$

6 And ſince the age of the *youngeſt ſonne* was half the age of the *eldeſt*; therefore the double of the ſecond *æquation* is equall to the fifth, *viz.* —— $2A = A + 3B$

7 If A bee *ſubtracted* from both parts of the ſixth, it will be —— $A = 3B$

8 By the firſt, it will be manifeſt that —— $3B = 12$

Therefore

Therefore *A* or the age of the *youngest son* was 12 *years*, and consequently the age of the 3d. *son* was 16. the age of the *second*, 20. and the age of the *eldest* 24. which is double the age of the *youngest* as was propounded.

Quest. 3. *A certain Turk in his journy to Mecha, to visit the Tomb of Mahomet, meets with a Pilgrim who begs an almes, to whom the Turk answers, If by thy prayer to Mahomet, thou canst cause the Dollars which I have in my purse to be doubled, I will give thee* 8 *Dollars; which the Pilgrim effected, and accordingly received* 8 *Dollars as a reward: In like manner the Turk meets with another Pilgrim, who by his prayer caused the Turks remaining Dollars to be doubled, and received* 8 *Dollars as a reward: And lastly, the Turk meets with a third Pilgrim, who by his prayer caused the Turks remaining Dollars to be doubled, and received* 8 *Dollars as a reward, and so the Turk had no Dollars left; The question is how many Dollars he had at the first?*

1 Let 8 the number of *Dollars* which the *Turk* gave to each *pilgrim* be — B
2 Let the number of *Dollars* which the *Turk* had in his purse at first be A
3 The number of *Dollars* which the *Turk* had in his purse being doubled, by virtue of the first *Pilgrims* prayer produce 2 *A*

4. If

4 If the first *equation* be subtracted from the third, the remainder is the number of *Dollars* which the *Turk* had left when hee departed from the first *Pilgrim*, *viz.* —— 2 A — B

5 The *Dollars* which the *Turk* had in his purſe when hee met with the ſecond *Pilgrim*, viz. 2 A — B (the fourth *equation*) being doubled produce —— 4 A — 2 B

6 If the first *equation* be ſubtracted from the fifth, the remainder is the number of *Dollars* which the *Turk* had left when he departed from the 2d. *Pilgrim*, *viz.* 4 A — 3 B

7 The *Dollars* which the *Turk* had in his purſe when hee met with the third *pilgrime*, *viz.* 4 A — 3 B (the ſixth *equation*) being doubled produce —— 8 A — 6 B

If

8 | If the firſt *equation* bee ſubtracted from the ſeventh, the remainder (according to the queſtion) muſt be equall to 0, therefore —— | $8A - 7B = 0$

9 | The eighth *equation* by *tranſpoſition* of $-7B$ will be —— | $8A = 7B$

10 | If both parts of the 9th be *applied* to 8, it will be —— | $A = \frac{7B}{8}$

But by the firſt *equation* $\frac{7B}{8}$ will be found 7, therefore A or the number of *Dollars* which the *Turk* had in his purſe at the firſt was 7. which will anſwer the conditions in the *queſtion*.

Queſtion 4. *A countrey maid going to the market, being asked by one that met her, how many eggs ſhe had in her basket; anſwered, if ſhe had 7 eggs more, ſhe ſhould make as much money in ſelling them all at 4 a penny, as in ſelling thoſe which ſhe had at 7 for 2 pence; The queſtion is, how many eggs ſhe had in her basket?*

1 | Let the 7 *eggs* in the queſtion be —— | B

2 | Let the 4 *eggs* in the queſtion be —— | C

3 Let

3 Let 1 (*penny* (the price of foure *eggs*) be — D

4 Then will 2 *pence* the price of 7 *eggs* be — $2D$

5 Let the number of *eggs* in the basket be — A

6 Find the price of all the *eggs* in the basket at the rate of seven *eggs* for two *pence*, and *say*, $B.\ 2D :: A.\ \frac{2DA}{B}$ So will the full price be — $\frac{2DA}{B}$

7 Again, adding seaven to the number of *eggs* in the basket, finde the price of that summe, after the rate of foure *eggs* for one penny, and *say*, $C.\ D :: A + B.\ \frac{DA + DB}{C}$ So will the full value be $\frac{DA + DB}{C}$

8 And

8 And since the two severall sums of money, computed as aforesaid, according to the conditions in the question, ought to bee equall, therefore the 7th. *aquation* is equall to the 6th. *viz.* $\frac{DA + DB}{C} = 2DA - B$

9 The 8th. *aquation* reduced, will be $BDA + BqD = C2DA$

10 The 9th. *aquation* by transposition of BDA, will be $BqD = C2DA - BDA$

11 If both parts of the 10th. bee applied to $C2D - BD$ it will be $\frac{BqD}{C2D - BD} = A$

12 The first part of the last *aquation* being resolved into number will be 49, which shewes that A or the number of *eggs* which the Maid had in her basket was 49.

Question 5. *A Gentleman hires a servant for a twelve moneth, for* 6 *pounds, and a Livery Cloake valued at a certain rate, but at seven moneths end they falling at variance, the Gentleman*

man puts away his servant, and gives him the Cloake, together with 50 shillings in money; and so the servant was fully satisfied for his time: the question is, what the Cloake was valued at?

1 Let the 12 *moneths* mentioned in the *question* be ——— B

2 Let the 7 *moneths* mentioned in the *question* be ——— C

3 Let the 6 *pounds* mentioned in the *question* be ——— D

4 Let the $2\frac{1}{2}$ *pounds* which the *Servant* received be ——— F

5 Let the *Cloake* be ——— A

6 Find what part of the *Cloake* was due to the *Servant* at 7 *moneths* end, and say, B.A :: C. $\frac{CA}{B}$. So the part of the *Cloake* due to the *Servant* at 7 *moneths* end, was ——— $\frac{CA}{B}$

7 Find

7 Find what part of the 6 lb. was due to the *Servant* at 7 *moneths* end, and say, B.D :: C. $\frac{DC.}{B}$ So the *money* due to the *Servant* at 7 *moneths* end, was — $\frac{DC}{B}$

8 Forasmuch as the *Cloake*, together with the money which the *Servant* received, ought to be equall to the part of the *Cloake* together with the part of the 6 *pounds*, due to the *Servant* at 7 *moneths* end; therefore the sum of the 4th. and 5th. *equations* must be equall to the summe of the 6th. and 7th. *equations*, *viz.*

$$F + A = \frac{CA + DC}{B}$$

The 8th. *equation* reduced will be $BF + BA = CA + DC$

10 The

10 The 9th. *equation* by transposition will be —— $BA - CA = DC - BF$

11 If both parts of the 10th. be applied to $B - C$ it will be —— —— $A = \frac{DC - BF}{B - C}$

The latter part of the 11th. being resolved into number, will be $2\frac{3}{5}$ *pounds*, which shewes that A or the *cloak* was valued at 2 l. 8 s.

Question 6.

Mulæ, Asinæque duos imponit servulus utres
Impletos vino; segnemque ut vidit Asellam
Pondere defessam vestigia figere tarda,
Mula rogat: quid chara pares cunctare, gemisq;?
Vnam ex utre tuo mensuram si mihi reddas,
Duplum oneris tunc ipsa feram; sed si tibi tradam
Vnam mensuram, fient æqualia utrique
Pondera: mensuras dic docte Geometer istas?

Facit, Mul. 7. Asin. 5.

1 Let the measures which the Asse carried be —— A

2 Then according to the question, the Asses measures increased with 1 measure taken from the Mule will bee equall to the Mules remaining measures; therefore the Mules remaining measures were —— A + 1

3 If 1 be added to the 2d *equation*, it gives the number of *measures* which the Mule had at the first, *viz.* $A + 2$

4 According to the question, the Mules measures increased with 1 measure taken from the Asse, will be equall to the double of the Asses remaining *measures*, viz. $A + 3 = 2\ A - 2$

5 The 4th. *equation*, by equall *Addition* and *Subtraction*, will be— $A = 5$

So it is manifest that the Asse or A carried 5 measures, and from the 3d. and 5th. it is also manifest that the Mule carried 7 measures.

Question 7. Two men were discourfing of their money in this manner, viz. A *saith to* B, *that* B *had three times as many pounds in his purse as* A, *and that if both their moneys were added together, the summe would be equall unto the Product when they were multiplyed one by the other; The question is, how many pounds each person had in his purse?*

1 Let

1 Let the leſſer number of *pounds* be —— —— A

2 Then according to the queſtion, the greater numb. of *pounds* is 3 A

3 The ſumme of both their *moneyes*; that is, of the firſt and ſecond *æquations* will be —— 4 A

4 If both their *moneyes* be multiplied one by the other; that is if the firſt *æquation* bee drawn into the ſecond, the *Rectangle* will be —— —— 3 Aq

5 But according to the queſtion, the *Rectangle* is equall to the ſumme; therefore the 4th. *æquation* is equall to the 3d. *viz.* 3 Aq = 4A

6 The 5th. *æquation* by depreſſion will be —— 3 A = 4

7 If both parts of the 6th. bee applied to 3, it will be —— A = 1 1/3

By the laſt *æquation* it is manifeſt that A or the perſon which had leaſt money, had 1 1/3 l. and conſequently the other perſon had the triple thereof, which is 4 l. which numbers 1 1/3 and 4 being multiplied one by the other, will produce their ſum which is 5 1/3. 5 1/3

Queſt. 8. *There are two numbers whoſe ſumme is* 10. *and if the greater be divided by the leſſe, the quotient will be* 20. *What are the Numbers?*

1 Let 10 (the *ſumme* of the 2 numbers) be—— B

2 Let 20 (the *quotient* propounded be—— C

3 Let the *greater number* ſought be—— A

4 It is manifeſt that if the *greater* of two numbers be *ſubtracted* from their ſumme, the remainder will be the leſſer; therefore the firſt *æquation* leſſe by the third is the *leſſer number*, viz. $B - A$

5 If the third *æquation* be applied to the fourth, there will ariſe $\frac{A}{B-A}$

6 According to the queſtion, if the *greater number* bee *divided* by the *leſſer*, the *quotient* muſt be 20; therefore the fifth *æquation* muſt be equall to the ſecond, *viz.*—— $\frac{A}{B-A} = C$

7 The 6th. *æquation reduced*, will be —— $A = CB - CA$

8 The 7th. by *tranſpoſition* of $-CA$ will be— $A + CA = CB$

If

9 If both parts of the 8th. bee *applied* to $1 + C$ it will be —— $A = \frac{CB}{1+C}$

10 The latter part of the 9th. being *reſolved* into *number*, it will be —— $A = 9\frac{11}{21}$

From the third and 10th. it is manifeſt, that the *greater number* ſought is $9\frac{11}{21}$, and from the firſt, fourth, and tenth; it is alſo manifeſt that the *leſſer number* is $\frac{10}{21}$, which two numbers will anſwer the conditions in the *queſtion*.

Queſtion 9. Three men have each of them a certain number of pounds in his purſe, viz. the ſumme of the firſt and ſecond mans money is 5 pounds; the ſumme of the ſecond and third is twelve pounds, and the ſumme of the third and firſt is 11 pounds: The queſtion is, how many pounds each man hath.

1 Let 5 the ſumme of the firſt and ſecond be —— B

2 Let 12 the ſumme of the ſecond and third be —— C

3 Let 11 the ſumme of the third and firſt be —— D

4 Let the firſt mans money be —— A

5 Let the ſecond mans money be —— E

6 Let the third mans money be —— I

7 Then according to the questions, the summe of the fourth and fifth *æquations* will be equal to the first, *viz.*— $A + E = B$

8 Also according to the question, the summe of the 5th. and 6th. *æquations* will be equall to the second, *viz.*— $E + I = C$

9 Also according to the question, the summe of the 6th. and 4th. *æquations* will be equall to the third, *viz.*— $I + A = D$

10 The sum of the 7th. 8th. and 9th. will be — $2A + 2E + 2I = B + C + D$

11 If in stead of $2A + 2E$ in the 10th. there be taken that wch is equall thereunto, *viz.* $2B$ (as is manifest by the 7th.) it will be — $2B + 2I = B + C + D$

12 The

12 The 11th. by equall *subtraction* of B, will be —— $B + 2I = C + D$

13 The 12th. by transposition of B, will be —— $2I = C + D - B$

14 If both parts of the 13th. be applied to 2, it will be —— $I = \frac{C + D - B}{2}$

15 The latter part of the 14th. being resolved into number, will be — $I = 9$

16 By the second, 8th. and 15th. it is manifest that — $E = 3$

17 By the third, 9 and 15th. it is manifest that — $A = 2$

By the 4th. 5th. 6th. and the 3 last *aquations* it is manifest that A or the *first man* had 2 pounds: E the second, 3 *pounds*; I the third, 9 *pounds*, which will answer the conditions in the *question*.

Question 10. *A Factor delivers 6 French Crowns and 2 Dollars for 45 shillings sterling; Also at another time he delivers 9 French*

Crowns and 5 Dollars (of the same Coin, and at the same rate with the former) for 76 shillings sterling; the question is to know the value of a French Crown; also of a dollar, in sterling money.

1 Let the 45 s. *sterling* mentioned in the question be — B

2 Let the 76 s. *sterling* mentioned in the *question* be — C

3 Let the value of a *French Crown* in *sterling money* be — A

4 Let the value of a Dollar in *sterling money* be — E

5 Then according to the *question*, 6 *Crowns* with 2 *dollars* are equall to 45 s. viz. $6A + 2E = B$

6 Also according to the *question*, 9 *French Crowns* with 5 *dollars* are equall to 76 *shillings*, viz. $9A + 5E = C$

7 The

7 The 5th. by tranſpoſition of $6A$, will be — $2E = B - 6A$

8 If both parts of the 7th. be *applied* to 2 it will be — $E = \frac{B-6A}{2}$

9 If both parts of the 8th. be *drawn* into 5 it will be — $5E = \frac{5B-30A}{2}$

10 If inſtead of $5E$ in the 6th. there be taken that which is equall thereunto, *viz.* the latter part of the 9th. the 6th. will be reduced into this. $9A + \frac{5B-30A}{2} = C$

11 The 10th. *æquation* reduced will be $5B - 2C = 12A$

12 If

12 If both parts of the 11th. be applied to 12, it will be — $\frac{5B - 2C}{12} = A$

13 If the first part of the 12th. be resolved into number, it will be — $6\text{ s. }1\text{ d.} = A.$

14 By the first, 8th. and 13th. it is manifest that — $4\text{ s. }3\text{ d.} = E$

By the 3d. 4th. 13th. and 14th. *equations*, it is manifest that a *French Crown* was equall unto 6 s. 1 d. and a *Dollar* equall unto 4 s. 3 d. which numbers will answer the conditions of the *Question*.

Question 11. *Three persons discourse of their money, in this manner*; viz. *The first saith to the other two, if* 100 *pounds be added to my money, the summe will be equall to both your moneyes; The second saith to the rest, if* 100 *pounds be added to my money, the summe will be equall to the double of both yours; The* 3d. *saith to the rest, if* 100 *pounds be added to mine, the summe will be equall to the triple of both yours: The question is how many pounds each person had.*

1 Let

1 Let 100 *pounds* mentioned in the *queſtion* be —— } B

2 Let the firſt mans *money* be } A

3 Let the ſecond mans *money* be } E

4 Let the third mans *money* be } I

5 Then according to the *queſtion*, the ſum of the firſt and ſecond *æquations* is equall to the ſum of the 3d. and 4th. viz. } $B + A = E + I$

6 Alſo according to the *queſtion*, the ſumme of the firſt and third is equall to the double of the ſum of the 2d. and 4th. viz. } $B + E = 2A + 2I$

7 Alſo according to the *queſtion*, the ſumme of the firſt and fourth is equall to the triple of the ſum of the 2d. and 3d. *æquations*, viz. —— } $B + I = 3A + 3E$

8 If the 2d. *equation* bee added to each part of the 5th. it will be — $B+2A=A+E+I$

9 The 8th. by *transposition* of E, will be — $B+2A-E=A+I$

10 If both parts of the 9th. be drawn into 2, it will be $2B+4A-2E=2A+2I$

11 If instead of the latter part of the 6th. there be taken that which is equall thereunto *viz.* the 1 part of the 10th. the 6th. will be reduced into this, viz. $B+E=2B+4A-2E$

12 The eighth by *transposition* of I, will be — $B+2A-I=A+E$

13 If each part of the twelfth bee drawn into 3, it will be — $3B+6A-3I=3A+3E$

14 If

14 If in ſtead of the latter part of the 7th. there be taken that which is equall thereunto, *viz.* the firſt part of the 13th. the 7th. will be *reduced* into this — $B + I = 3B + 6A - 3I$

15 The 11th. by equall *Addition* and *Subtraction*, will be — — $3E = B + 4A$

16 If each part of the 15th. be *applied* to 3, it will be $E = \frac{B + 4A}{3}$

17 The 14th. by equall *Addition* & *Subtraction*, will be — — $4I = 2B + 6A$

18 The 17th. *applied* to 4, will be $I = \frac{2B + 6A}{4}$

19 The *ſumme*, of the 16th. and 18th. will be — $E + I = \frac{5B + 17A}{6}$

20 If the 2d. be added to each part of the 19th. it will be — $A + E + I = \frac{23A + 5B}{6}$

21 If

21 If in stead of the first part of the 20th. there bee taken that which is equall thereunto *viz.* the first part of the 8th. the 20th. will be *reduced* into this, *viz.*— $B + 2A = \frac{23A + 5B}{6}$

22 The 21th. *reduced*. will be — $6B + 12A = 23A + 5B$

23 The 22th. by equall *Subtraction* will be— $B = 11A$

24 If both parts of the 23th. be *applied* to 11, it will be $\frac{B}{11} = A$

25 The 1 part of the 24th. being *resolved* into *number* this will arise *viz.*— $9\frac{1}{11} = A$

26 From the first 16th. and 25th. it will be manifest that— $45\frac{5}{11} = E$

27 Also

27 | Alſo from the firſt 18th. and 25th. it will be manifeſt that — } $63\frac{7}{11} = I$

By the 2d. 3d. 4th. and the 3 laſt *Æquations* it is manifeſt that the firſt *Man* had $9\frac{3}{11}$ lb. the 2d. $45\frac{3}{11}$ lb. and the 3d. $63\frac{7}{11}$ lb. which three numbers will anſwer the conditions in the *queſtion.*

Queſtion 12. *If* 100 *be given to be divided into* 4 *ſuch parts, that the firſt part being increaſed with* 7, *the* 2d. *part leſſened by* 7, *the* 3d. *part multiplied by* 7, *and the fourth part divided by* 7, *the ſumme, remainder, Product and Quotient may be equall between themſelves, what will be the parts ?*

1 | Let 100 (mentioned in the *queſtion*) be — } C

2 | Let 7 (mentioned in the *queſtion*) be — } B

3 | Let the 1. *part* be — } A

4 | Let the 2d. *part* be — } E

5 | Let the 3d. *part* be — } I

6 | Let the 4th. *part* be — } O

7 Accord-

7 According to the *question*, if 7 be *added* to the 1. *part* and *subtracted* from the 2d. the *sum* and the *remainder* will be equall; therefore the *sum* of the 2d. and 3d. *aequations* is equall to the 4th. lesse by the 2d. *viz.* $B + A = E - B$

8 The 7th. *Æquation* by *transposition* of $-B$ will be —— $2B + A = E$

9 According to the *Question*, if the third *part* bee *multiplyed* by 7, the *Product* will be equall to the *summe* of 7, and the first *part*; therefore the *summe* of the second and third *aequations* will be equall to the *Rectangle* under the second and fifth, *viz.* $B + A = BI$

10 If both *parts* of the ninth be *applyed* to B, it will be — $\frac{B + A}{B} = I$

11 According

11 According to the *queſtion*, if the fourth part be *divided* by 7, the *quotient* will be equall to the *ſumme* of 7, and the firſt *part*, therefore if the ſixth *æquation* be *applied* to the ſecond, the quotient will be equall to the *ſumme* of the ſecond and third *æquations*, *viz.* ——— $B + A = \frac{O}{B}$

12 The 11th. *æquation reduced*, will be ——— $Bq + BA = O$

13 *For aſmuch as all the parts are equal to the whole*, therefore the *ſum of the* 3d. *æquation*, together with the 1 parts of the 8th. 10th. and 12th. will bee equall to the firſt *Æquation*, viz. $\frac{2BA + 2Bq + A + B + Bq\,A + Bc}{B} = C$

14 The 13th. reduced will be-- $2E\,A+2Bq+A+B+Bq\,A+Bc=BC$

15 If the 14th. be *resolved* into *numbers*, and the *numbers* added, it will be—— $64\,A+448=700$

16 The 15th. by *equall Subtraction* of 448 will be—— $64\,A=252$

17 If both parts of the 16th. be *applied* to 64. it will be—— $A=3\frac{11}{16}$

18 By the 2d. 8th. and 17th. it will be manifest that— $E=17\frac{11}{16}$

19 By the 2d. 10th. and 17th. it will be manifest that—— $I=1\frac{9}{16}$

20 By the 2d. 12th. and 17th. it will be manifest that—— $O=76\frac{9}{16}$

The latter parts of the 4 last *equations* are the numbers sought, which will answer the conditions in the *question*.

Question 13. *Certain Noblemen being disposed to take their pleasure in a Progresse, carried with them a certain number of pounds*, viz. *every one as many pounds as the other, and so many Noblemen as there were, so many servants had each Nobleman to attend him; Also the number of pounds that each Nobleman carried was double the number of all the servants, and the summe of all their money was* 3456 *pounds: The question*

stion is, how many Noble men there were, also how many pounds each carried with him?

1 Let 3456 (mentioned in the *queſtion*) be —— } *B*

2 Let the number of *Noblemen* be } *A*

3 Then according to the *queſtion*, the number of *ſervants* attending each *Nobleman* will be alſo —— } *A*

4 It is alſo manifeſt that if the ſecond *æquation* bee *drawn* into the third, it gives the number of all the *ſervants, viz.* —— } *Aq*

5 And ſince by the queſtion, the double of the number of *ſervants* was the number of *pounds* which each *Nobleman* had: therefore the fourth *æquation drawn* into 2 gives the ſaid number of *pounds, viz.* } 2 *Aq*

6 It is alſo manifeſt, that if the ſecond *æquation* bee *drawn* into the 5th. the rectangle will be the ſumm of *pounds* which all the *Noblemen* had, *viz.* —— } 2 *Ac*

7 But by the firſt *æquation* it is manifeſt, that the ſumme of *pounds* which all the *Noblemen* had, was *B*, which muſt be equall to the 6th. *æquation, viz.* —— } 2 *Ac* = *B*

8 | 8 The 7th. *aquation* being *applyed* to 2 it will be ——— } $Ac = \frac{B}{2}$

9 | The *Cube root* of $\frac{B}{2}$ that is, of 1728 being *extracted*, it will be } $A = 12$

From the 2d. 3d. 5th. and 9th. *aquations* it is manifeſt that there were 12 *Noblemen*, and each had 288 *pounds*; Alſo each *Nobleman* had 12 *ſervants* to attend him.

Queſtion 14. *If* 4050 *Souldiers are to bee ſet in battell in a rectangular Figure, in ſuch manner that the number in File may be to the number in ranke as* 1 *to* 2, *how many Souldiers are to be placed in Ranke, and how many in File? Or which is the ſame in effect, a Rectangle together with the proportion of the ſides is given to find the ſides.*

1 | Let 4050 or the *Rectangle* be } B

2 | Let (1) the *leſſer term* of the *Proportion* be ——— } R

3 | Let (2) the *greater terme* of the *Proportion* be ——— } S

4 | Let the *leſſer ſide* unknown, or the number of men to be placed in *File* be ——— } A

5 Then

5 Then according to the *queſtion*, As 1 is to 2, ſo is the number in *File* to the number in *Ranke*; therefore $R.S::A.\frac{SA}{R}$. ſo the number to be ſet in *Rank* or the *greater ſide* will be —— $\frac{SA}{R}$

6 *Multiply* the *leſſer ſide* by the *greater*, viz. *draw* the fourth *æquation* into the fifth, ſo will the Product be —— $\frac{SAq}{R}$

7 Since the *Factus* or *Product* of 2 ſides is equall to the *Rectangle* made of them, therefore the ſixth *Æquation* is equall to the firſt, *viz.* —— $\frac{SAq}{R}=B$

8 The ſeventh *æquation* reduced is — $SAq=RB$

9 If both parts of the ſeventh be applied to S it will be —— $Aq=\frac{RB}{S}$

10 The ninth reduced into proportionalls will be —— $S.R::B.Aq$

The 10th. *æquation in words is the following Theoreme*, viz. *As the greater term of the proportion given is to the leſſer, ſo is the number of men to be ſet in battell, (or the Rectangle) to the ſquare of the leſſer ſide (whether it be Ranke or File) and conſequently the ſquare root of the ſaid fourth proportionall is the leſſer ſide; If the*

greater side had been A, then the Theoreme would have been as followeth.

As the lesser term of the proportion given is to the greater: so is the Rectangle (or number of men to be set in battell) to the square of the greater side (whether it be Ranke or File) and consequently the square root of the said fourth proportionall is the greater side.

Illustration.

The 10th. *Æquation resolved into numbers will be as followeth.*

1. *As* 2 — 1 — 4050 (2025 (45 *Men in File*
2. *As* 1 — 2 — 4050 (8100 (90 *Men in Rank*

The proofe — 4050

Or when one of the sides is found by the preceding *Theoreme*, the other may bee found by *Division*, viz.

$$\frac{4050}{45} = 90 \quad \text{Or} \quad \frac{4050}{90} = 45$$

Question 15. *There are three numbers in Geometricall proportion continued*, viz. *the mean proportionall is* 24, *and the sum of the extremes is* 80, *what are the extremes?*

1 Let

1 Let 24, (the *mean proportionall*) be —— } *B*

2 Let 80 (the *ſum* of the *extremes*) *be* —— } *C*

3 Let the *leſſer extreme* be —— } *A*

4 Then ſubtracting the *leſſer extreme* from the ſumme of the *extremes*, *viz.* the third *æquation* from the ſecond, the remainder will be the greater *extreme*, *viz.* } *C — A*

5 The *Product* of the *extremes*, (*viz.* the third *Æquation drawn* into the fourth) is —— } *CA-Aq*

6 By 20 & 7 *Euclid. Elem.* the 5th. *æquation* is equall to the ſquare of the firſt, *viz.* — } *CA — Aq = Bq*

Wherefore by *Rule* I. in *pag.* 387 it will be as followeth, *viz.* ——

$$\frac{C}{2} - \sqrt{n : \frac{Cq}{4} - Bq :} = A \text{ the leſſer extreme}$$

$$\frac{C}{2} + \sqrt{n : \frac{Cq}{4} - Bq :} = A \text{ the greater extreme}$$

Which Theoreme in words will be thus expreſſed, viz.

If half the summe of the extremes be lessened by the Square root of the remainder found by subtracting the Square of the meane from $\frac{1}{4}$ *of the Square of the summe of the extremes, it gives the lesser extreme: Or half the summe of the extremes increased with the Square root of the remainder found, &c. gives the greater extreme.*

By which *Theoreme*, the *extremes* will bee found 8, and 72, so that the numbers 8. 24. 72. are continuall proportionalls, the Mean being 24 and the summe of the extremes 80, as was propounded.

Question 16. *A Merchant buyes clothes, and selleth them at* 17 $\frac{1}{4}$ *lb. the piece, and gaineth in* 100 *lb. as many pounds as he paid for one piece; the question is what he paid for a Cloth?*

1 Let 100 lb. mentioned in the question be —— *B*

2 Let 17 $\frac{1}{4}$ lb. mentioned in the question be —— *C*

3 Let the gaine of one Cloth be —— *A*

4 Then subtracting the gain of a Cloth from all the money received for a Cloth, the remainder will bee the *first cost* of a Cloth, *viz.* the 2d. *æquation* lesse by the 3d. is —— *C — A*

5 Again

5 Again, as the *first cost* of a Cloth is to the gain thereof, so is 100 ℔. to the gain thereof, *viz.* $C - A . A :: B . \frac{BA}{C-A}$ so the gain of 100 ℔. will be $\frac{BA}{C-A}$

6 According to the question, the gain of 100 ℔. was equall to the *first cost* of a *Cloth*, therefore the 5th. *aquation* will bee equall to the 4th. *viz.* $\frac{BA}{C-A} = C - A$

7 The 6th. *aquation reduced*, will be $BA = Cq - 2CA + Aq$

8 The 7th. by *transposition*, will be $BA + 2CA - Aq = Cq$

And by *Rule* I. in *pag.* 387 it will be as followeth:

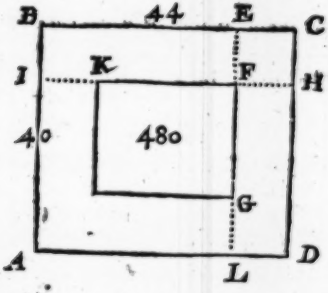
$$\frac{B + 2C}{2} - \sqrt{u : \frac{Bq + 4CB + 4Cq}{4} - Cq :} = A$$

By which *Theoreme* the *gain* of a *Cloth* will be found $2\frac{1}{4}$ ℔. which being subtracted from $17\frac{1}{4}$ ℔. (the price for which a *Cloth* was sold) leaves 15 ℔. for the *first cost* of a *Cloth*, as will be manifest by the following proportion.

15 — $2\frac{1}{4}$ — 100 — (15

Question

Question 17. *A certain Nobleman intending to make a Garden of pleasure, gives directions to a Surveyor to lay forth* 11 *Acres in a long Square, whose length may be* 44 *poles, and breadth* 40 *poles; Moreover, he desires to have* 3 *Acres in a pond, to lie in another long Square within the former, and in such manner that there may be one and the same parallell distance between the sides of the long Squares: The question is to know the length and breadth of the pond, also the said Parrallell distance?*



1 Let *BC* or *AD*(44) the *length* of the greater *long square* be —— } *B*

2 Let *BA* or *CD* (40) the *breadth* of the same *long square* be —— } *C*

3 Let

3 Let the *Area* of the *pond* or interiour long ſquare, *viz.* 3 *Acres*, or 480 *Perches* be—— } *D*

4 Let the parrallell diſtance *EF*, or *HF* be—— } *A*

5 Then it is manifeſt that the length of the interiour long ſquare, *viz.* *KF*, is equall to *IH* or *BC*, leſſe by the double of the parrallell diſtance *HF*, therefore the firſt *æquation* leſſe by the double of the fourth is the length of the interiour long ſquare, *viz.*—— } *B* - 2 *A*

6 It is alſo manifeſt that the breadth of the interiour long ſquare *viz.* *FG* is equall to *EL* or *CD* leſſe by the double of the Parrallell diſtance *EF*, therefore the 2d. *æquation* leſſe by the double of the fourth, is the breadth of the interiour long ſquare *viz.* } *C* - 2 *A*

7 The rectangle under the fifth and ſixth *Æquations*, is —— } *BC* - 2 *BA* - 2 *CA* + 4 *Aq*

8 The

8 The 7th. *Æquation* being the *Area* of the interiour long ſquare is equall to the third, *viz.* $BC-2BA-2CA+4Aq=D$

9 The 8th. by *tranſpoſition* will give this— $BC-D=2BA+2CA-4Aq$

10 If both parts of the ninth be applied to 4 it will be— $\frac{BC-D}{4}=\frac{BA+CA}{2}-Aq$

11 And by *Rule* I. in *page* 387 it will be as followeth;

$$\frac{B+C}{4}-\sqrt{u}:\frac{Rq-2BC+Cq+4D}{16}:=A$$

Which Theoreme will be thus expreſſed in words, viz.

If $\frac{1}{4}$ *of the ſumme of the length and breadth of the greater long ſquare be leſſened by the ſquare root of* $\frac{1}{16}$ *of the Aggregate of the quadruple*

druple Area of the interiour long ſquare, and the ſquare of the difference between the length and breadth of the greater long ſquare, it gives the parrallell diſtance between them.

12 By the aforeſaid *Theoreme* the parrallell diſtance will be found — 10

13 Alſo from the firſt, fifth, and twelfth it will be manifeſt that *FK* the length of the interiour long-ſquare is — 24

14 And from the ſecond, ſixth, and twelfth it will be manifeſt that *FG* the breadth of the interiour long ſquare is — 20

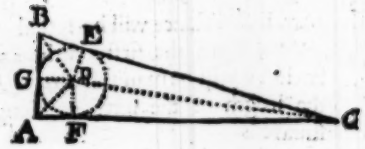
15 Laſtly, the Product of the thirteenth and fourteenth is the *Area* of the interiour long ſquare or pond, *viz.* 480

Queſtion, 18. *There is a right-angled Triangle A B C whoſe Area is 40, and the Perimeter or ſumme of all the 3 ſides is alſo 40, what are the ſides?*

Preparation

Preparation.

Vid. Briggii Arith. Logarithm. Cap. 15. Sect. 8.



In any plain Triangle, the Semi-perimeter multiplyed by the Semidiameter of the Inscribed Circle produceth the Area of the Triangle, and consequently if the Area be divided by the Semi-perimeter, the Quotient will be the Semidiameter of the inscribed Circle: So in the aforesaid *Triangle* it is manifest that if *D E* (the *Semidiameter* of the *Inscribed Circle*) be multiplyed by the half of *B C*, the Product will be the *Area* of the *Triangle D B C*; Also *D F* multiplyed by $\frac{1}{2}$ of *A C* produceth the *Area* of the *Triangle A D C*; and *D G* multiplyed by $\frac{1}{2}$ of *A B* produceth the *Area* of the *Triangle B D A*; which three *Triangles* are equall to the *Triangle A B C*.

Moreover,

Moreover, by the aforesaid Diagram it will be manifest, that in any right-angled plain Triangle, the Diameter of the inscribed Circle is equall to the difference between the Hypothenusall and the summe of the sides containing the right angle, For $CF = CE$ and $BG = BE$, therefore $CF + BG = BC$. Also it is manifest if $CF + BG$ ($= BC$ the *Hypothenusall*) be subtracted from $CA + BA$ (the *summe* of the *containing sides*) the remainder will bee $FA + GA = DG + DF =$ the *Diameter* of the *Inscribed Circle*; which *premisses* being observed, the *Hypothenusall* of the aforesaid *Triangle* will be found 18, and the *summe* of the *containing sides*, 22. For if 40 the *Area* of the *Triangle* be divided by the *Semiperimeter* 20, the qnotient will be 2 for the *Semidiameter* of the Inscribed Circle; therefore the *Diameter* is 4, which being subtracted from the *Perimeter* 40, the remainder is 36, whose halfe is 18 for the *Hypothenusal BC*, which subtracted from 40 the Perimeter, leaves 22 for the *summe* of the *containing sides*, then proceed to find the said *sides* as followeth, *viz.*

1 Let BC (18) the *Hypothenusal* be — B

2 Let 22 the *summe* of the containing sides AC, AB, be — C

3 Let one of the containing sides be — A

4 Then

4 Then it is manifest that the second *æquation* lesse by the third is the other containing side, *viz.* $C - A$

5 The square of the first *æquation* is —— Bq

6 The square of the third is — Aq

7 The square of the fourth is — $Cq - 2CA + Aq$

8 The *summe* of the sixth and seventh is — $Cq - 2CA + 2Aq$

9 By 47 è 1 *Euclid. Elem.* the eighth *æquation* is equall to the fifth, *viz.* $Cq - 2CA + 2Aq = Bq$

10 The ninth by *transposition*, will be — $Cq - Bq = 2CA - 2Aq$

11 If both parts of the tenth bee *applyed* to 2 it will be — $\frac{Cq - Bq}{2} = CA - Aq$

12 And by *Rule* I. in *page* 387 it will be as followeth:

$\frac{1}{2}C$

$\frac{1}{2}C. + \sqrt{u : \frac{2Bq-Cq}{4}} : = A$ (*the greater ſide*)

$\frac{1}{2}C - \sqrt{u : \frac{2Bq-Cq}{4}} : = C - A$ (*the leſſer ſide*)

Which Theoreme will bee thus expreſſed in words, viz. If halfe the ſumme of the containing ſides of a right angled plain Triangle, be increaſed with the ſquare root of $\frac{1}{4}$ *of the remainder found by ſubtracting the ſquare of the ſaid ſumme from twice the ſquare of the Hypothenuſal, the Aggregate will be the greater containing ſide; Or if halfe the ſumme of the containing ſides be leſſened by the ſquare root of* $\frac{1}{4}$ *of the remainder found, &c. it leaves the leſſer containing ſide.*

By which Theoreme, the greater containing ſide of the aforeſaid Triangle will bee found $11 + \sqrt{41}$. or 17. 403124 &c. and the leſſer containing ſide will bee found $11 - \sqrt{41}$ or 4. .596875, &c.

Illustration Arithmeticall.

The Hypothenusal BC — 18
The Base AC — 17.403124, &c.
The Perpendicular AB — 4.596875, &c.

The Perimeter — 39.999999

The Base AC — 17.403124, &c.
Half the Perpendicular AB — 2.298437, &c.

The Area — 39.9999, &c.

Whereby it is manifest, that the *Area* of the aforesaid *Triangle* is equall to the *Perimeter*, as was propounded.

Question 19. *The Hypothenusal and Area of a right angled Triangle being known, to find the sides.*

1 Let the *Hypothenusal* be — } *H*
2 Let the *Area* be — } *C*
3 Since the double *Area* is equall to the *Rectangle* under the *Base* and *Perpendicular*; therefore the Rectangle under the Base and Perpendicular is — } 2*C*
4 Let one of the sides containing the right angle be — } *A*

5 k

5 It is manifeſt that the Rectangle or Product of two numbers being divided by one of them, the Quotient will bee the other; therefore if the third *equation* be applied to the fourth, the Quotient will be the other containing ſide of the Triangle, *viz.* $\frac{2C}{A}$

6 The ſquare of the firſt *equation* is — Hq

7 The ſquare of the fourth *equation* is — Aq

8 The ſquare of the fifth *equation* is — $\frac{4Cq}{Aq}$

9 The ſumme of the 7th and 8th *equations* is — $\frac{Aqq + 4Cq}{Aq}$:

10 By the 47 è 1 *Euclid. Elem.* the 8th. *equation* is equall to the 6th. *viz.* — $\frac{Aqq + 4Cq}{Aq} = Hq$

11 The 10th. *equation* reduced is — $Aqq + 4Cq = HqAq$

12 The 11th. by tranſpoſition of *Aqq* will be — $4Cq = HqAq - Aqq$

13 And by Rule I. in *page* 387 it will bee as followeth. —

$$\frac{Hq}{2} + \sqrt{u : \frac{Hqq}{4} - 4Cq :} = Aq \text{ the square of the greater side.}$$

$$\frac{Hq}{2} - \sqrt{u : \frac{Hqq}{4} - 4Cq :} = \frac{4Cq}{Aq} \text{ the square of the lesser side.}$$

Which Theoreme will be thus expressed in words, viz.

If half the square of the Hypothenusall be increased with the square root of the remainder found by subtracting the quadruple of the square of the Area from $\frac{1}{4}$ *of the Biquadrate of the Hypothenusal, it gives the square of the greater containing side, and consequently the square root of the said aggregate is the said containing side: Or if half the square of the Hypothen. be lessened by the square root of the remainder found, &c. it gives the square of the lesser containing side; and consequently the square root of the last remainder is the lesser containing side: So if the Hypothenusal be* 5 *and the Area* 6 *the greater containing side will be found (by the aforesaid Theoreme) to be* 4, *and the lesser containing side* 3.

Question 20. *There are* 3 *numbers in Geometricall proportion continued, the mean proportionall being* 24, *and the difference of the extremes is* 140, *What are the extremes?*

1 Let

1 Let the mean proportionall be —— } B

2 Let 140 the difference of the extremes be —— } C

3 Let the leſſer extreme be — } A

4 Then if the difference of the extremes be added to the leſſer extreme, the ſumme will be the greater extreme; therefore the ſumme of the ſecond and third *æquations* is the greater extreme, *viz.* —— } $C + A$

5 The Rectangle under the extremes, *viz.* the third *æquation* drawn into the fourth is } $CA + Aq$

6 By 20 & 7. *Euclid. Elem.* the 5th. *æquation* is equall to the ſquare of the firſt, *viz.* } $CA + Aq = Bq$

7 Wherefore by Rule II. in *page* 388 it will be as followeth:

$$\sqrt{u : \frac{Cq}{4} + Bq} : - \frac{C}{2} = A$$

Which Theoreme in words, will be thus expreſſed, viz.

If the ſquare root of the ſumme of $\frac{1}{4}$ *of the ſquare of the difference of the extremes, and the*

square of the mean proportionall be lessened by half the difference of the extremes, the remainder will be the lesser extreme.

So by the said *Theoreme* there will be found 4 for the lesser extreme, which added to 140 (the difference of the extremes) gives 144 for the greater extreme; and therefore the numbers 4. 24. 144. are continuall proportionalls, the mean proportionall being 24, and the difference of the extremes 140 as was propounded.

Question 21. *A Factor buyeth certain pieces of Sattins and Taffeties in such sort that a yard of Sattin cost more then an Ell of Taffety; also 2 yards of Sattin together with three Ells of Taffety cost* 51 *shillings, and the difference between the squares of the price of a yard of the one, and of an Ell of the other was* 176 *s. The question is to know the price of a yard of Sattin; also of an Ell of Taffety?*

1 Let the 51 s. mentioned in the question be —— } *B*

2 Let the 2 yards of Sattin be } *C*

3 Let the 3 Ells of Taffety be } *D*

4 Let the 176 s. mentioned in the question be —— } *G*

5 Let the price of a yard of Sattin be —— } *A*

6 Let the price of an Ell of Taffety be —— } *E*

7 If

7 If (according to the queſtion) the ſecond *Æquation* be drawn into the fifth, it gives the price of 2 yards of Sattin, *viz.*— } *CA*

8 Alſo according to the queſtion, if the third æquation be drawn into the ſixth, it gives the price of 3 Ells of Taffety, *viz.*— } *DE*

9 The fifth æquation ſquared, is the ſquare of the price of a yard of Sattin, viz.— } *Aq*

10 The ſixth æquation ſquared, is the ſquare of the price of an Ell of Taffety, viz.— } *Eq*

11 Since a yard of Sattin coſt more then an Ell of Taffety, the ninth æquation leſſe by the tenth will bee the difference of the ſquares of the price of a yard of the one, and of an Ell of the other, viz.— } *Aq — Eq*

12 According to the queſtion, the difference of the ſquares of the price of a yard of the one, and of an Ell of the other is 176; therefore the 11th. is equal to the 4th. viz. } *Aq — Eq = G*

13 Also according to the question, the summe of the seventh and eighth æquations will be equall to the first, viz. $CA + DE = B$

14 The thirteenth æquation by transposition of CA, will be — $DE = B - CA$

15 If both parts of the fourteenth bee applyed to D it will be — $E = \frac{B - CA}{D}$

16 The square of the 15th. will be — $Eq = \frac{Bq - 2BCA + CqAq}{Dq}$

17 If in stead of Eq in the 12th. you take that wch is equal unto it, viz. the latter part of the 16th. this æquation wil arise, viz. $Aq - \frac{Bq - 2BCA + CqAq}{Dq} = G$

18. The

18 The 17th. reduced will be $AqDq - Bq + 2BCA - CqAq = DqG$

19 The 18th. by transposition of $-Bq$ will be $AqDq + 2BCA - CqAq = DqG + Bq$

20 If both parts of the 19th. be applied to $Dq - Cq$, it will be $Aq + \frac{2BCA}{Dq - Cq} = \frac{DqG + Bq}{Dq - Cq}$

21 If the known quantities of the twentieth bee resolved into numbers it will be $Aq - \frac{224}{5}A = 837$

22 And

22 And by the *Rule* II. in *page* 388 the price of a yard of Sattin will bee found 15 s. *viz.* $u: \frac{10404}{25} + 837: - \frac{102}{5} = A = 15$

23 Also from the first, second, third, sixth, 15th. and 22th. *æquations* the price of an Ell of Taffety will bee found 7 s. *viz.* —— $E = 7$

Question 22. *In a right angled plain Triangle, there being given the Base together with the Product of the Hypothenusal and Perpendicular, to finde the Hypothenusal and Perpendicular;*

1 Let the Base be —— B

2 Let the Product of the Hypothenusal and Perpendicular be — C

3 Let the Perpendicular be — A

4 It is manifest that if the Product of 2 numbers be divided by one of them, the quotient will bee the other, therefore if the 2d. *æquatiõ* be *applied* to the 3d. the *quotient* will be the *Hypothenusal*, *viz.* $\frac{C}{A}$

5 The

5 The ſquare of the *Hypothenuſal* viz. of the 4th. *æquation* is — Cq Aq

6 The ſquare of the *Baſe*, viz. of the firſt *æquation* is — Bq

7 The ſquare of the *Perpendicular*, viz. of the 3d. *æquation* is — Aq

8 The ſumme of the 6th. and 7th. *æquations* is — $Bq + Aq$

9 By the 47 è 1. *Euclid. Elem.* the 8th. *æquation* is equall to the 5th. *viz.* — $Bq + Aq = \frac{Cq}{Aq}$

10 The 9th. *æquation* reduced, will be — $Bq\ Aq + Aqq = Cq$

And by *Rule* II. in *page* 388 it will bee as followeth, *viz.*

$$\sqrt{u : \frac{Bqq}{4} + Cq :} - \frac{Bq}{2} = Aq$$

Which Theoreme will bee thus expreſſed in words, viz.

If the ſquare root of the ſumme of $\frac{1}{4}$ *of the Biquadrate of the Baſe, and the ſquare of the Product of the Hypothenuſal and Perpendicular, be leſſened by half the ſquare of the Baſe, the remainder will be the ſquare of the Perpendicular, and conſequently the ſquare root of the ſaid remainder will be the Perpendicular.*

So

So if the Base bee 3, and the Product of the Hypothenusal and Perpendicular bee 20, the Perpendicular will be found (by the aforesaid Theoreme) to be 4. Lastly, the Base and Perpendicular being known, the Hypothenusal will be found (by the 47 è 1 *Euclid. Elem.*) to be 5.

Question 23. *A Merchant buyes two sorts of linnen cloth*, viz. 90 *Ells of one sort together, with* 40 *Ells of a worser sort for* 42 lb. *and he finds that in laying forth* 1 *pound upon each sort he hath* $\frac{1}{3}$ *of a yard more of the worser sort then of the other; The question is what a yard of each sort did cost?*

1 Let the 90 Ells of the better sort be —— } *B*

2 Let the 40 Ells of the worser sort be —— } *C*

3 Let 42 lb. the full cost of both sorts be —— } *D*

4 Let the number of Ells of the better sort bought for 1 lb. be — } *A*

5 Then according to the question, the number of Ells of the worser sort bought for 1 lb. will be — } $A + \frac{1}{3}$

6 Find the full cost of the worser sort, viz. say, $A + \frac{1}{3}$. 1 :: C. $\frac{3C}{3A+1}$ } $\frac{3C}{3A+1}$

So the full cost will be ——

7 Find

7 Find the full coſt of the better ſort, viz. ſay, $A.\ 1 :: B.\ \frac{B}{A}$ } $\frac{B}{A}$

8 So the full coſt will be $\frac{B}{A}$

The ſum of the ſixth and ſeventh *Æquations* is the full coſt of both ſorts, $\frac{3CA + 3BA + B}{3Aq + A}$

9 According to the queſtion, the full coſt of both ſorts, was 42 lb. or *D.* therefore the 8th. *æquation* is equall to the 3d. *viz.* $\frac{3CA + 3BA + B}{3Aq + A} = D$

10 The ninth *æquation* reduced is $3CA + 3BA + B = 3DAq + DA$

11 The tenth by tranſpoſition of $3CA + 3BA$ will be $B = 3DAq + DA - 3CA - 3BA$

12 If both parts of the eleventh bee applied to $3D$ it will be $\frac{B}{3D} = Aq + \frac{DA - 3CA - 3BA}{3D}$

13 The 12th. being resolved into number and reduced will be— $Aq - \frac{18}{21}A = \frac{5}{7}$

14 Wherefore by *Rule* III. in *page* 389 it will be— $\frac{12}{21} + \sqrt{\frac{1114}{441}} = A = 3$

By the fourth and 14th. *equations* it is manifest that the number of Ells bought for 1 lb. of the better sort was 3, and consequently by the question, the number of Ells of the worser sort bought for 1 lb. was $3\frac{1}{3}$, whence by the *Rule* of 3 it will be manifest that 1 Ell of the better sort did cost 6 s. 8 d. and 1 Ell of the worser sort, 6 s. which two prices will answer the conditions in the question.

Question 24. *Two Merchants*, viz. A *and* B. *enter into company*, A *puts in a summe of money for* 3 *moneths, and* B *puts in* 50 lb. *more then* A *for* 5 *moneths; they gain together* 140 lb. *whereof* A *takes so much that if* 60 lb. *be added to it, the*

the ſum will be equall to the ſtock wherewith he entred company; The queſtion is, what was the ſtock and gain of each Merchant?

1	Let 3 (the number of moneths belonging to the firſt Merchants ſtock) be—	*B*
2	Let 50 lb. (the difference of their ſtocks be)—	*C*
3	Let 5 (the number of moneths belonging to the ſecond Merchants ſtock) be—	*D*
4	Let 140 lb. (the totall gain) be—	*F*
5	Let 60 lb. (the difference between the firſt Merchants ſtock and his gain) be—	*G*
6	Let the ſtock of the firſt Merchant be—	*A*
7	Then will the ſumme of the ſecond and ſixth *æquations* bee the ſecond Merchants ſtock, *viz.*—	*C* + *A*
8	The Rectangle of the firſt and ſixth *æquations* is the Product of the firſt Merchants ſtock multiplied by his time, *viz.*—	*BA*
9	The Rectangle of the third and ſeventh *æquations* is the Product of the ſecond Merchants ſtocke multiplied by his time, *viz.*—	*DC* + *DA*

10 Since

10 Since (according to the *Rule* of *Fellowship*) the sum of the eighth and ninth *aquations* is in such proportion to the eighth as the fourth *aquation* is to the gain of the first Merchant, *viz.*

$DC+DA+BA.BA :: F. \frac{FBA}{DC+DA+BA}$

therefore the gain of the first Merchant is — $\frac{FBA}{DC+DA+BA}$

11 The summe of the fifth and tenth *aquations* is $\frac{FBA+GDC+GDA+GBA}{DC+DA+BA}$

12 According to the question the 11th. must bee equall to the 6th. viz. $\frac{FBA+GDC+GDA+GBA}{DC+DA+BA} = A$

13 The 12th. reduced will be $FBA+GDC+GDA+GBA=DCA+DAq+BAq$

14 The

14 The 13. by transpositiō will be $DAq + BA + DCA - FBA - GDA - GBA = GDC$

15 If both sides of the 13th. be applied to $D + B$ it will be $Aq + \frac{DCA - FBA - GDA - GBA}{D+B} = \frac{GDC}{D+B}$

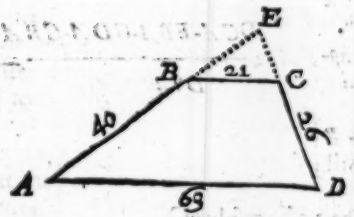
16 The 15th. resolved into numbers will be $Aq - 81\frac{1}{4}A = 1875$

Wherefore by *Rule* III. in *page* 389 the value of *A* or the first *Merchants stocke*, will bee found 100 lib. unto which if 50 lib. be added, the summe will be 150 lib. for the stock of the second *Merchant*, then working as in the *Rule of Fellowship* with time, the gain of the first *Merchant* will be found 40 lib. and the gain of the other will be found 100 lib. which numbers will answer the conditions in the question.

Question 25. *There is a Trapezium* A B C D *which hath two parallel sides*, viz. A D and B C.

and all the foure sides are knowne, viz. AB, 40 | BC 21. | CD, 26 | *and* AD. 63. *The question is to know the superficiall Content or Area of the Trapezium.*

Preparation.



If the sides *AB*, *DC* be continued unpill they meet in the point *E*, there will be two *equiangled Triangles*, *viz*. *EBC*, *EAD*, whose sides are proportionall by 4. *è* 6 *Euclid*. It is also manifest that if the *Area* of the *Triangle EBC* be subtracted from the *Area* of the *Triangle EAD*, the remainder will be the *Area* of the *Trapezium ABCD*, which premisses being observed, the *Analysis* will be as followeth, *viz*.

1 Let

1	Let AB, (40) be ——	$> B$
2	Let BC (21) be ——	$> C$
3	Let CD (26) be ——	$> D$
4	Let AD (63) be ——	$> F$
5	Let the *continuation* BE be —	$> A$
6	Find a fourth *proportionall* unto the sides EB, BC, EA, viz. respect being had unto the *Symbols*, it will bee $A.\ C :: A \div B \cdot \frac{CA \div CB}{A}$ So the fourth proportionall is ——	$> \frac{CA \div CB}{A}$
7	Forasmuch as the *triangles* EBC, EAD are equiangled; therefore the sixth *Æquation* must be equall to the fourth, *viz.*	$\frac{CA \div CB}{A} = F$
8	The seventh *reduced*, will be —.	$CA \div CB = FA$
9	The eighth by *transposition* of CA will be —	$CB = FA - CA$
10	If both parts of the eighth be *applyed* to $F-C$ it will be ——	$\frac{CB}{F-C} = A$
11	The tenth *reduced* into *proportionals* will be —	$F-C.C :: B.\ A$
12	The 11th. in words is the following *Theoreme*, viz.	

As the difference between the lengths of the parallel sides is to the shorter parallel; so is the greater of the two sides which are not parallels, to the continuation thereof to meet with the lesser side which is not parallel: Or so is the lesser side to the lesser continuation.

13 By the said *Theoreme*, the *continuation* B E will be found 20, also the *continuation* C E will be found 13, and consequently the side E A is 60, and E D, 39.

14 By the 3 sides E A, A D, E D, the *Area* of the *triangle* E A D will be found —— 1134

15 Also by the 3 sides E B, B C, E C the *area* of the *triangle* E B C will be found —— 126

16 Lastly, if the *area* of the *triangle* E B C be subtracted from the *area* of the *triangle* E A D, the remainder wil be the *area* of the *Trapezium* A B C D *viz.* —— 1008

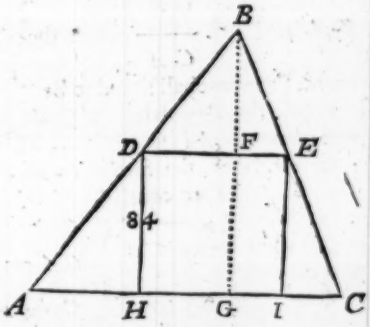
Question 26. *There is a Triangle* A B C *whose sides are known,* viz. A B, 195 | A C, 182 | B C, 169. *Within which Triangle there is a square inscribed,* viz. H D E I: *The question is to know the side of said square,* viz. D E *or* D H?

Preparation.

Preparation.

Let fall the *Perpendicular* BG, then will the *triangles* BFD, BGA be equiangled, also BFE, BGC are equiangled (by 29 *è* 1 *Euclid.*) therefore their sides will be proportionall (by 4 *è* 6 *Euclid.*) from whence these proportions will arise, *viz.*

$$BF.FD :: BG.GA$$
$$BF.FE :: BG.GC$$
$$2BF.FD + FE :: 2BG.GA + GC.$$
$$BF.FD + FE :: BG.GA + GC$$



Whence it is manifest that *BF.DE* : : BG. *AC* which being laid as a ground, the *Analysis* will be as followeth, *viz.*

1 Let AC, (182) be —— > B

2 Let BG, 156 (found by the three sides AB, AC, CB) be —— C

3 Let DE or FG the side of the *inscribed square* be —— A

4 It is manifest that BF is the difference between BG and FG; therefore the second *æquation* lesse by the third, is equall to BF which is —— $C-A$

5 Find a fourth proportionall unto BF, DE, BG, *viz.* respect being had unto the *Symbols*, it will bee $C-A. A :: C. \frac{CA}{C-A}$ So is the fourth Proportionall found to be $\frac{CA}{C-A}$

6 From the *Proportions* first *demonstrated* it is manifest, that the fifth *æquation* must bee equall to the first, *viz.* —— $\frac{CA}{C-A} = B$

7 The sixth *æquation* reduced will be —— $CA = BC-BA$

8 The seventh by *transposition* of - BA will be $CA + BA = BC$

9 If both parts of the 8th bee *applyed* to $C + B$ it will be —— $A = \frac{BC}{C+B}$

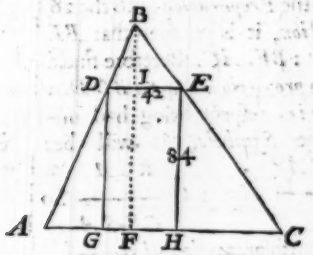
10 The

10 | The ninth reduced into *Proportionals* will be { C + B. B :: C. A

The 10th *in words is the following Theoreme*, viz. *As the summe of the Base and perpendicular, is to the Base; so is the perpendicular to the side of the inscribed square.*

By which *Theoreme*, the side *DE* or *DH* will be found 84.

Question 27. *There is a Triangle* ABC, *whose sides are known*, viz. AC. 140 | AB. 130 | *and* BC. 150, *within which Triangle it is required to inscribe a long square; whose length may be to the breadth in any proportion assigned*, viz. *as* 2 *to* 1, *the question is to know the length and breadth of the said inscribed long square?*



1 | Let *AC*, 140 be ——————> B

2 | Let *BF*, 120. (found by the sides *AB*, *BC*, and *AC*.) be —— { C

3	Let 1. the *lesser terme* of the *proportion* assigned be ——	R
4	Let 2. the *greater terme* of the *proportion* be ——	S
5	Let DE or GH, the *breadth* of the *long square* be ——	A
6	Since the *breadth* is to the *length* as 1 to 2, *viz.* $R.S. :: A.\frac{SA}{R}$ therefore DG or IF the length of the *long square* is equall unto ——	$\frac{SA}{R}$
7	It is manifest that BI is the *difference* between BF and IF; therefore the 2d. *æquation* lesse by the 6th. is equall to BI which is ——	$\frac{CR-SA}{R}$
8	By the *Preparation* unto the 26 *Question*, it is manifest that $BI.DE :: BF.AC$. therefore find a fourth *proportionall* unto $BI.DE.BF$. *viz.* respect being had unto the *Symbols*, it will bee $\frac{CR-SA}{R}.A :: C.\frac{RCA}{CR-SA}$ So the fourth *proportionall* is ——	$\frac{RCA}{CR-SA}$

9 By

9 By the afore mentioned Preparation it will be alſo manifeſt that the eighth *æquation* muſt be equall to the firſt, *viz.* $\frac{RCA}{CR-SA} = B$

10 The ninth reduced will be $RCA = BCR - BSA$

11 The tenth by *tranſpoſition* of $-BSA$ will be $RCA + BSA = BCR$

12 If both the parts of the 11th bee *applyed* to $RC + BS$ it will be $A = \frac{BCR}{RC + BS}$

13 The twelfth *reduced* into *proportionalls* will be $RC + BS . BC :: R . A$

The 13th *in words is the following Theoreme, viz. As the Aggregate of the Rectangle (or Product) of the perpendicular of the Triangle and the leſſer terme of the proportion aſſigned, and the Rectangle under the Baſe and greater terme of the ſaid proportion, is to the rectangle of the Baſe and Perpendicular; So is the leſſer terme of the ſaid proportion to the breadth of the long Square.*

By which *Theoreme* the breadth of the *long ſquare* propounded will be found 42, and conſequently, by the *Rule* of 3 and the *proportion* aſſigned

assigned, the length will be found 84, or the length might bee found *Analytically*, from whence another *Theoreme* would arise.

I shall conclude with an *Ænigma* wherein divers difficult *questions* are involved, the resolution whereof will discover a certain *Sentence* consisting of three words, concerning which you are to observe, that by each *letter* is understood the *number* which shewes the *seat* or *distance* of such letter from the beginning of the *Alphabet*, so by *C* the third *letter* in the *Alphabet* is understood 3, by *F* 6. by *P*, 15, &c. which numbers may be called the *Indices* of their respective *letters*, so that the *Index* of any *letter* being known, the *letter* is cõsequently discovered

The *Ænigma* followeth.

The *Product* or *Rectangle* of the *difference*, and the *difference* of the *Squares* of the *Indices* belonging to the second *letter* of the second *word* and the third *letter* of the first *word* is 576, and the *Rectangle* or *Product* of their *summe*, and the *summe* of their *Squares* is 2336, the *Index* of the said third *letter* being the greater.

The *Index* of the latter of the two before mentioned *letters* is the last of four numbers in *Arithmeticall proportion*, and the *Index* of the former is the first of the said foure *proportionalls*, the *lesser Meane* is the *Index* of the first

letter

letter of the 3d *word* and the greater *Meane* is the fourth or laſt *letter* of the firſt *word*.

The 2d. *letter* of the 3d. *word* is the ſame with the 3d. *letter* of the *firſt word*.

The fifth *letter* of the 3d. *word* is the ſame with the *laſt letter* of the *firſt*.

The *ſumme* of the *ſquares* of the *Indices* of the firſt and ſecond *letters* of the firſt *word* is 520, and the Product of the ſaid *Indices* is equall to $\frac{2}{9}$ of the *ſquare* of the *greater Index* which is the *Index* of the ſaid *firſt letter*.

The *difference* between the laſt mentioned *Indices* is the *Index* of the firſt letter of the 2d. word.

The third or *laſt letter* of the ſecond *word*; alſo the third *letter* of the 3d. *word* are the ſame with the 2d. *letter* of the firſt word.

The *ſumme* of the *Indices* anſwerable to the 4th letter of the third *word* and the 6th or *laſt letter* of the ſame word being added to the Product or Rectangle under them is 33, and the difference of their ſquares is 255, the *Index* of the ſaid *laſt letter* being the leſſer.

The *inveſtigation* of the *Indices* by which the *letters* are conſequently diſcovered, I leave to the ſcrutiny of the ingenious *Analyſt*.

Soli Deo gloria.

Arts and Sciences Mathematicall,

Taught

At the comet house (opposite to the *white Lion*) in *Charles-street*, neare the *Piazza* in *Covent-garden*, or at the lodgings of such as are desirous, *viz.*

ARITHMETIQUE,

1. *In whole Numbers,*

2. *In Fractions* { *Vulgar,* *Decimall,* *Astronomicall.*

3. *The extraction of roots, viz. of the* { *Square,* *Cube,* *Biquadrate.* *Quadrato-Cube,* &c. } by *Rules* naturally arising frō the *Geneſis* of *Powers.*

4. *Merchants Accompts*, in the *Italique* methode of *Debitor* and *Creditor*, according to the modern practice.

ALGE-

ALGEBRA, *viz.*

1. In *Numbers* and *Characters* according to the *Ancients*.
2. In *Species* or *Letters* of the *Alphabet*, according to the modern *Analysts*.

} with the use thereof in the invention of *Theoremes* and resolution of subtile *Questions* and *Problems* in *Arith.* and *Geometry*.

GEOMETRIE, *viz.*

The works of *Eucl. Archimedes, Apollonius Pergæus, Pappus*, and other *Geometricians*, as well *ancient* as *modern*, explained & applied unto

1. Divers wayes of *Construction, Mensuration, Reduction*, and *Division* of superficia *Figures, viz.* of *Land, Board, Wainscot, Glasse*, &c. Also of *Solids*, as *Timber, Stone*, &c. with the *Gaging of Cask*.
2. The *Projection* of *Planisphares, Maps, Charts*, (*universall* or *particular*) *Plots* of *Land, Architecture*, &c. with the *augmenting* or *diminishing* of them, according to any proportion assigned.

THI

The DOCTRINE of TRIANGLES, *viz.*

1. *Plain* — With their use, in finding of *Altitudes* and *Distances*, in measuring of *Land*, *Fortification*, *Dyalling*, *Navigation*, *Theories* of the *Planets*, &c.

2. *Spherical* — With their use, in the resolution of the usuall *Propositions* of the *Celestiall* and *Terrestriall Globes*, *Dyalling*, *Navigation*, &c.

NAVIGATION, *viz.*

In either of the 3 *principal kinds of sayling*, viz.
- By the *plain Chart*.
- By *Mercators Chart*.
- By *great Circle*.

DYALLING, *viz.*

1. *Geometrically*,
2. *Instrumentally*
3. *Arithmetically*

With the *inscription* of the *Almicanthars*, *Azimuths* *parallels* of *Declination*, &c. Also the making of *reflexive Dyals*, shewing the houre without any shadow.

The

The Construction and Use of
MATHEMATICALL
INSTRUMENTS, *viz.*

1. The *Canon* of { *Sines, Tangents, Secants,* and *Logarithmes.*

2. The *Quadrant, Sector, Crosse-staffe, plain Table, Rule of Proportion, Instrumentall Dyals,* &c.

CHIROGRAPHIE, *viz.*

The Art of accurate and exact *Hand-writing,* in the *English* and best *Italique* formes, by genuine *Principles,* and plain *Demonstrations.*

BY

JOHN KERSEY
Philomathet.

Vox audita perit, litera scripta manet.